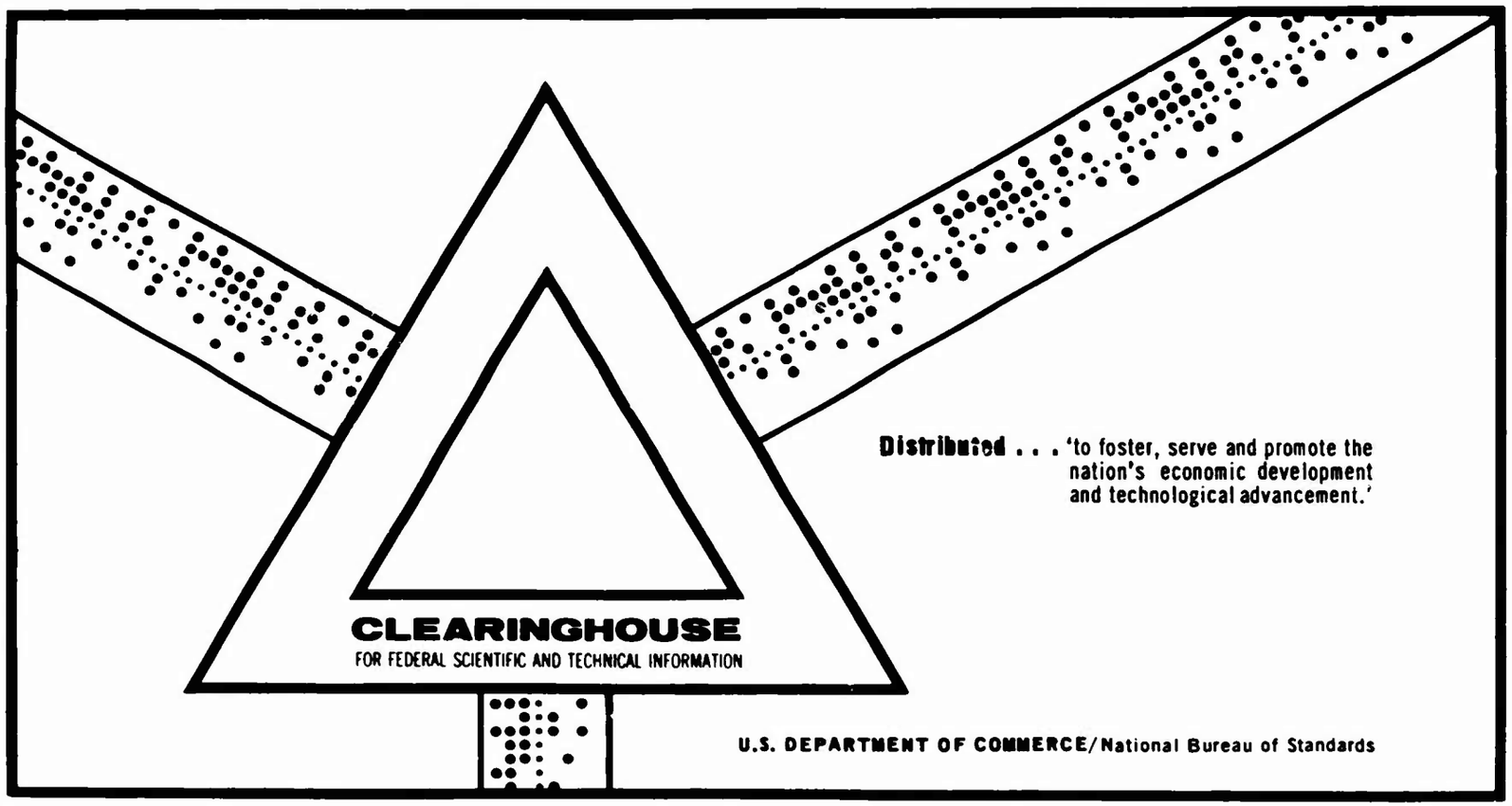
COMPUTER ASSISTED TARGET ANALYSIS

Margo J. Kelly, et al

Raytheon Company
Alexandria, Virginia

November 1969



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November 1969

COMPUTER ASSISTED TARGET ANALYSIS

Autometric/Raytheon Company

Rome Air Development Center
Air Force Systems Command
Griffiss Air Force Base, New York

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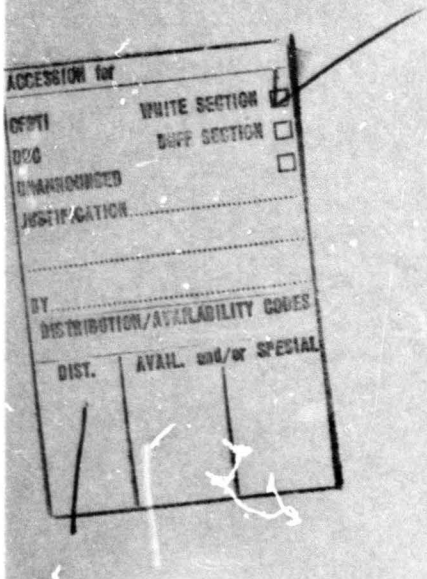

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COMPUTER ASSISTED TARGET ANALYSIS

Margo J. Kelly
John B. Kellom
Autometric/Raytheon Company

FOREWORD

This final report describes work carried out by the Autometric Operation of Raytheon Company, 4217 Wheeler Avenue, Alexandria, Virginia, for Rome Air Development Center, Griffiss Air Force Base, New York, under Contract F30602-69-C-0194, Project 698DB, entitled "Computer Assisted Target Analysis." Anthony Jeric, EMIRE, acted as project monitor for the government and John Kellom was program manager for Autometric. Autometric personnel who participated in this study were Margo Kelly, Richard Marshall, and Barbara Olmstead.

This technical report has been reviewed by the Information Office, EMLS, and is releasable to the Clearinghouse for Scientific and Technical Information.

This technical report has been reviewed and is approved.

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for IRVING J. GABELMAN
Chief, Plans Office

ABSTRACT

The "Computer Assisted Target Analysis" program cataloged in computer form the ground truth data collected at the UNDERBRUSH Test Range, Eglin Air Force Base, Florida. A Fortran IV program compatible with the GE-645 computer was developed for storing, retrieving and correlating the data, and providing a means for updating as more data are compiled. Contained within is a complete program documentation including step by step operating procedures and logic flow diagrams. In addition, the data reduction methodology and program test results are described.

TABLE OF CONTENTS

1. INTRODUCTION

The "Computer Assisted Target Analysis" study is designed to catalog in computer form the ground truth data collected at the UNDERBRUSH Test Range, Eglin Air Force Base, Florida, to store, retrieve, and correlate the data, and to provide a means for future updating as more data are compiled.

Basically this report can be divided into two segments. The first part presents the complete program documentation for the computer program and associated subroutines which were developed in support of this study. Each salient portion of the program is described in detail, including flow charts, program operation description, inputs and outputs, and operating instructions. This documentation section is intended primarily for use by persons familiar with the GE-645 computer and Fortran IV language. The information contained in this documentation will permit any modification to the program to be undertaken in an efficient manner.

The second part discusses the techniques used in data reduction, presents the computer test results undertaken to simulate operational requirements, and considers potential applications of the program. Information on the alphabetic and numeric codes used in the data reduction are explained in Appendix A.

2. GENERAL SYSTEM DESIGN AND OPERATION

The program created for the "Computer Assisted Target Analysis" study was designed for the GE-645 computer using the GECOS III configuration. Fortran IV language was used throughout the entire programming cycle.

The basic program, mnemonic COMATAN, is composed of the following eight subroutines: STORE, RETRIV, BRITE, CORREL, ARRAY, MISR, PLOT, and SCAL. A detailed description of these subroutines is presented in subsequent sections.

Before examining the component parts of the program an understanding of the overall system design is important. This section, therefore, describes the operation of the COMATAN program, the options available, and the set-up of the card decks.

In order to operate this program two magnetic tape units, a card reader, and a printer must be available. Of the two magnetic tapes used for this study, one contains all the encoded UNDERBRUSH ground truth data, and the other is a scratch tape used for retrieval compilation.

Basically the program is written in three parts: storage, retrieval, and correlation phases.

2.1 Storage Phase

The function of the storage phase is to compile all the formatted ground truth data onto a master magnetic tape. There are three options available:

1. Initial Store
2. Additional Store
3. Housekeep Store.

The initial store option pertains to the loading of data from punch cards onto the magnetic tape for the first time. This option is exercised when creating a master tape from the data cards.

Since ground truth data are being continually generated, it would be advisable to update the master tape periodically. The second option, additional store, provides for this operation. Here additional data in the form of punch cards can be added to the master tape.

The last option, housekeep store, is used for a tape-to-tape transfer of data from the master tape which may become worn to a fresh tape. It serves as a means of preventing the loss of data on an old tape and having to generate a new tape from the punch cards again.

2.2 Retrieval Phase

The retrieval phase, wherein all the data are searched and the desired information printed out, is the crux of the entire program. Six options, two input and four output, are available.

2.2.1 Input Options

1. The requestor may rup up to 10 cases with each case composed of up to 35 limits.

2. The above option may be run for any number of users on the same execution. This allows for an almost indefinite number of parameter variations to be compiled from the master tape.

2.2.2 Output Functions

1. Retrieve the requested records on input-formatted punch cards.

2. Retrieve the records with appropriate case number on a blocked, input-formatted magnetic tape.

3. Retrieve the records with the appropriate case number to an on-line printer.

The four output options are: neither 1 nor 2, 1 not 2, 2 not 1, and both 1 and 2. In all instances the retrieval records are printed out, function 3.

2.3 Correlation Phase

There are no options in the correlation phase, instead the retrieved data are processed through the entire correlation program.

2.3.1 Correlation Phase Input

Input to the correlation phase is from the magnetic tape generated during the retrieval phase, limited to only one user, but with up to ten cases available. A control card stating each

individual case number to be used and the respective X and Y parameters to be correlated must be provided.

2.3.2 Correlation Phase Output

Output to the correlation phase consists of the following items:

1. X-mean
2. Y-mean
3. X-variance
4. Y-variance
5. Correlation coefficient
6. Regression line plotted.

2.4 Card Deck Set-Up

The COMATAN program has five execution options which are presented below.

1. Store
   No Retrieve
   No Correlate
   } 1, 0, 0

2. Store
   Retrieve
   No Correlate
   } 1, 1, 0

3. Store
   Retrieve
   Correlate
   } 1, 1, 1

4. No Store
   Retrieve
   No Correlate } 0, 1, 0

5. No Store
   Retrieve
   Correlate } 0, 1, 1

On the following five pages each of these execution options are illustrated with respect to the card deck set-up.

2.5 Data Cards and Control Cards

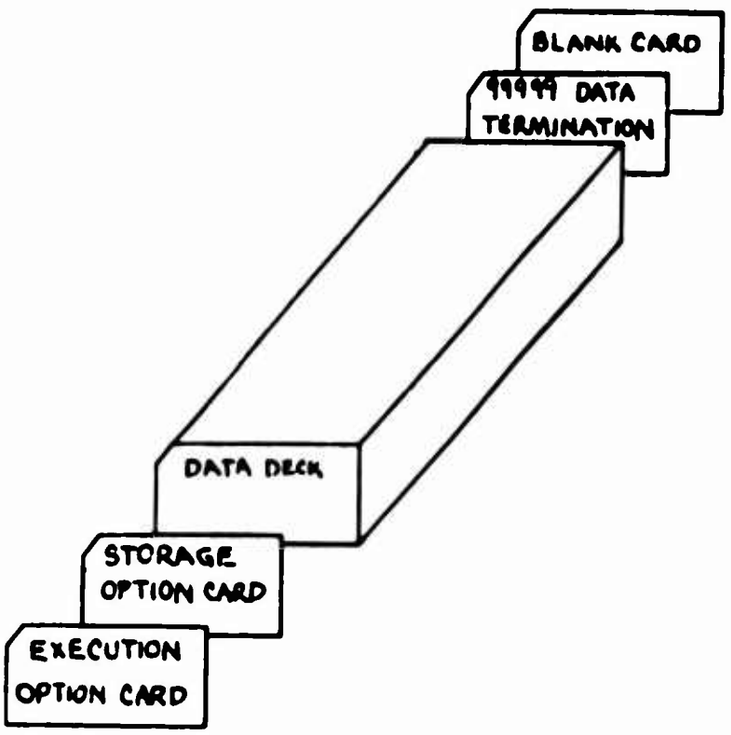
In order to utilize the COMATAN program, as in the case with any computer program, not only must the card deck be properly sequenced, but the various cards must be correctly keypunched. This subsection tabularizes the control and data cards, showing the required format, and describing various encoded parameters.

2.5.1 Execute Option Card

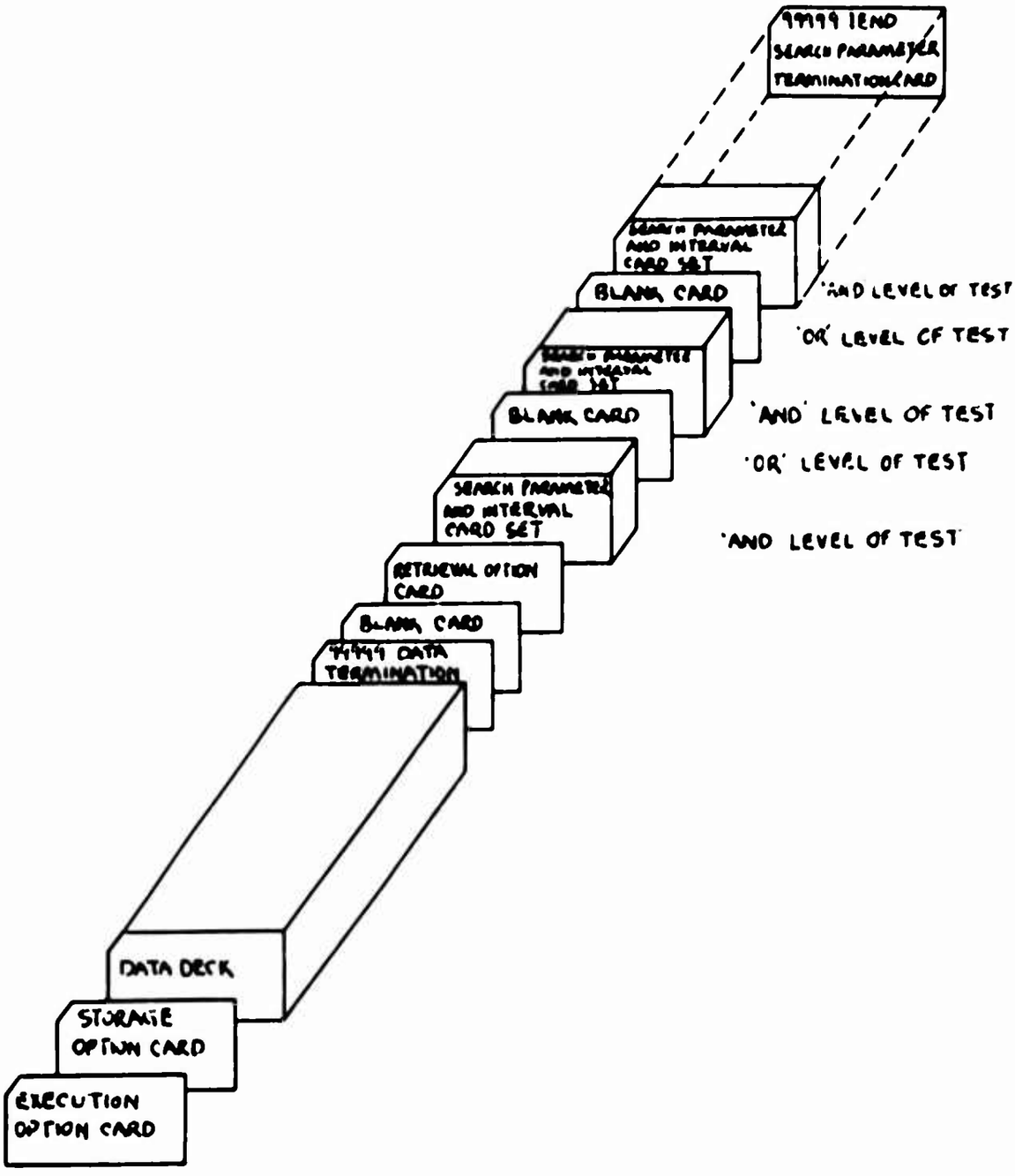
COLUMN	ITEM	FORMAT
1	Storage Phase Flag (ISTORE)	I1
2	Retrieval Phase Flag (IRETRV)	I1
3	Correlation Phase Flag (ICOREL)	I1

FOR EACH { 0 = Do not execute phase
           1 = Execute phase

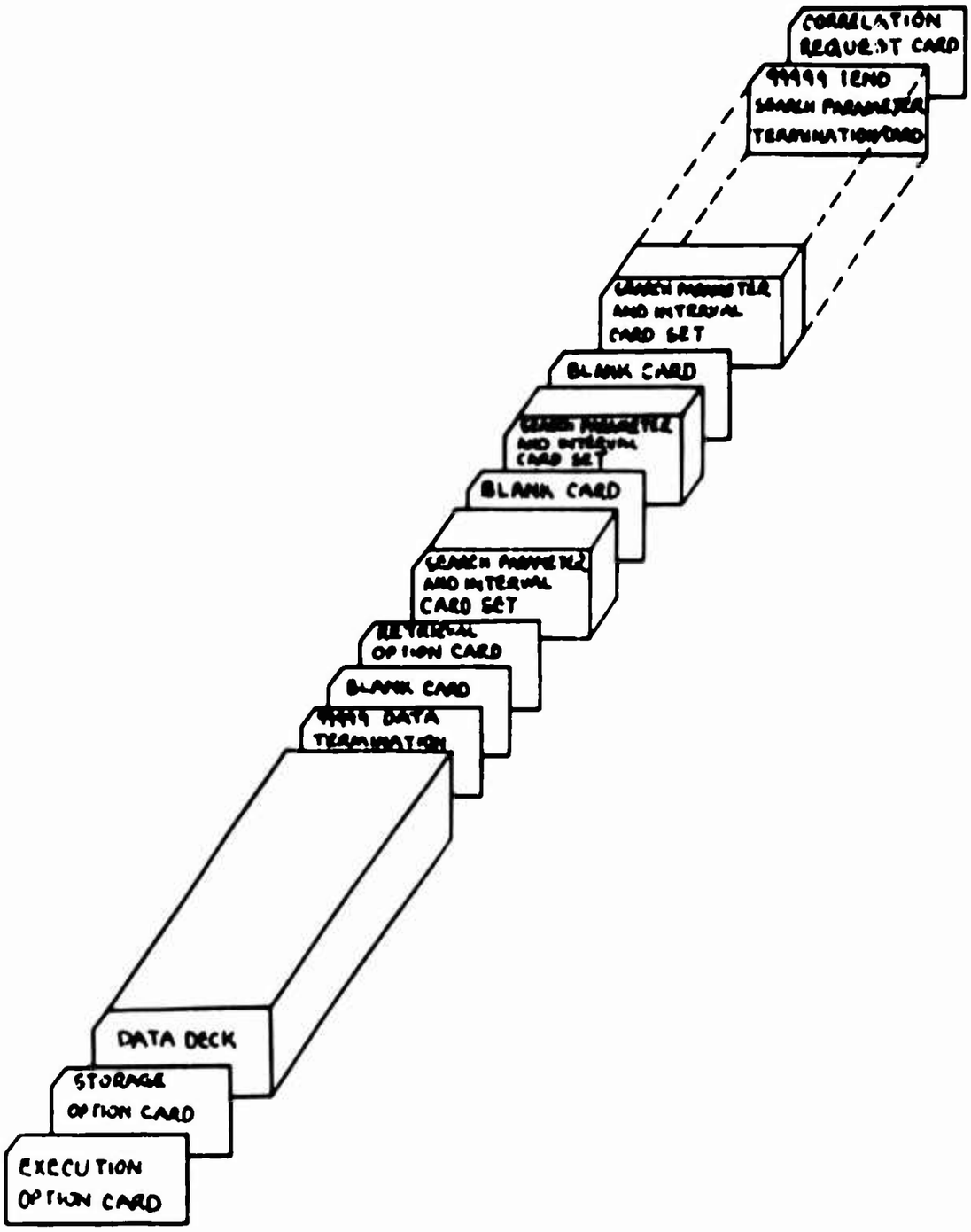
CARD DECK SET-UP: EXECUTION OPTION 1



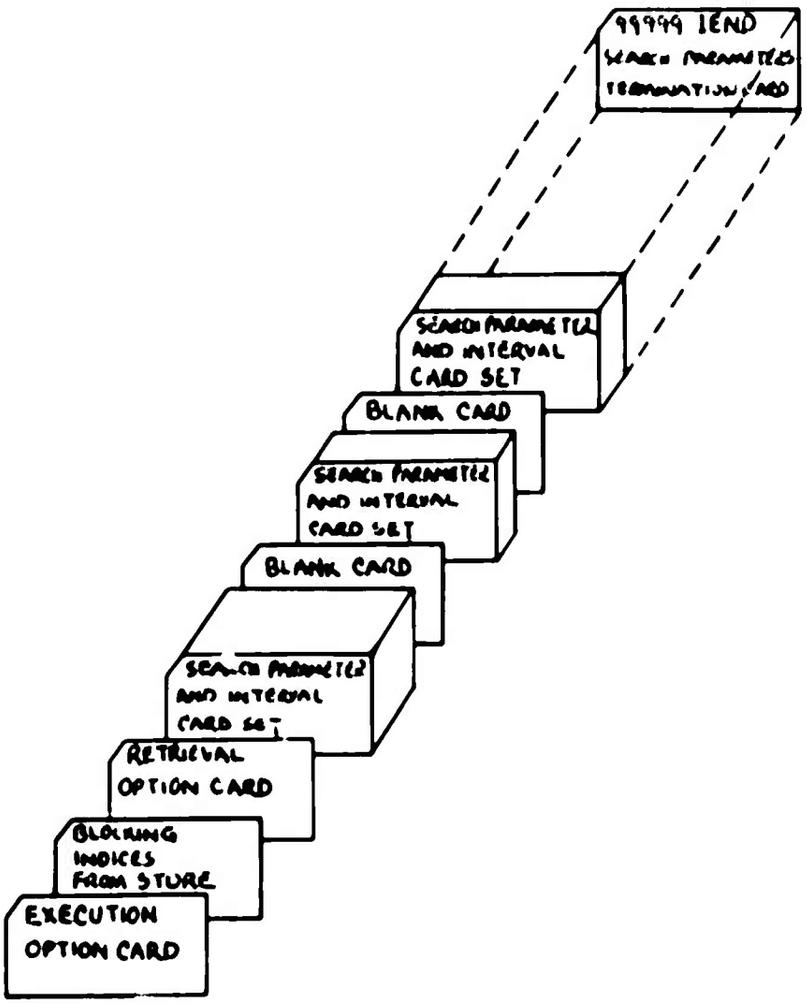
CARD DECK SET-UP: EXECUTION OPTION 2



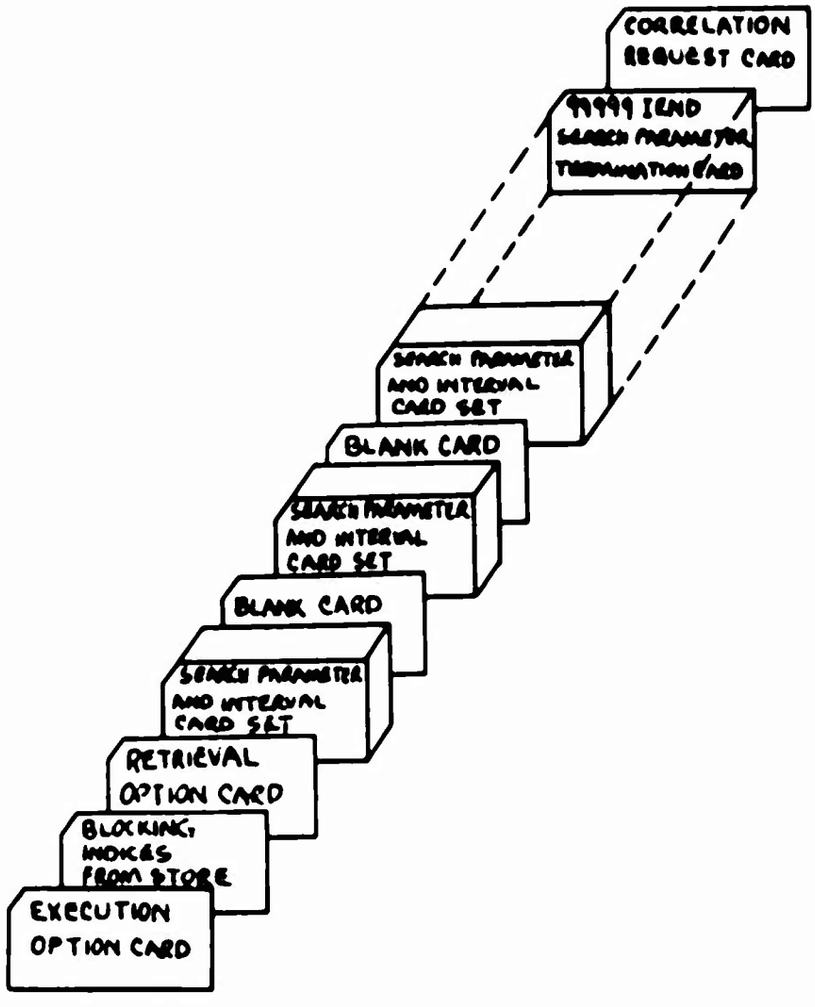
CARD DECK SET-UP: EXECUTION OPTION 3



CARD DECK SET-UP: EXECUTION OPTION 4



CARD DECK SET-UP: EXECUTION OPTION 5



2.5.2 Storage Option Card

COLUMN	ITEM	FORMAT
1	Type of Storage to be done (IRUN) 0 = Initial data store 1 = Copy tape and add data from cards 2 = Copy from old tape all data onto new tape- "Housekeeping"	I1

2.5.3 Blocking Indices Card

COLUMNS	ITEM	FORMAT
1	Tape Drive Number Where Data Tape is Located(ITAPE)	I1
2 - 6	Number of Full Blocks of Data On Tape(IPABC1)	I5
7 - 8	Number of Records in Last Block (IPABC2)	I2

NOTE: A Full Block of Data = Ten Records

A Record = Two-Card "UNDERBRUSH" Data Sets

2.5.4 Data Deck

CARD 1

COLUMNS	ITEM	FORMAT
1 - 5	MISNAM - Mission Name	A5
6 - 9	MISNUM - Mission Number	A4
11	SENTYP - Sensor Type	I1
13 - 14	SENDES - Sensor Designation	I2
16 - 21	IDATE - Date	I6
23 - 25	AIRCRF - Aircraft	A3

27	LOCAT - Location	A1
29 - 32	SUNRIZ - Sunrise	I4
34 - 37	SUNSET - Sunset	I4
39 - 42	MUNRIZ - Moonrise	I4
44 - 47	MUNSET - Moonset	I4
49 - 52	LOCTIM - Time (Local)	I4
54	SKYCOV - Sky Cover	I1
56 - 57	CLHITE - Height (Clouds)	I2
59	CLTYPE - Type (Clouds)	I1
61 - 62	WINDIR - Wind Direction	A2
64 - 65	WINSPD - Wind Speed (Knots)	A2
67 - 68	WESTAT - Weather Status	A2
70 - 72	WETBUB - Wet Bulb (F)	I3
** 77 - 80	Sequential Card Identification- Never Read, Written, or Processed	I4

CARD 2

COLUMNS	ITEM	FORMAT
1 - 3	DRYBUB - Dry Bulb (F)	I3
5 - 7	RELHUM - Relative Humidity %	I3
9 - 11	SOLRAD - Solar Radiation	I3
13	PRECIP - Precipitation	A1
15	GRDVIS - Ground Visibility	I1
17 - 18	DEWPTF - Dew Point (F)	I2
20 - 22	REFCUB - Reference Cube	I3
24 - 26	BGRRES - Background Results	I3
28 - 30	BGRTEM - Background Temp (C)	I3

	32	MUNPHA - Moon Phase	I1
	34 - 37	SBRITW - Standard Brightness (Whole)	I4
	38 - 42	SBRITD - Standard Brightness (Decimal)	I5
	44 - 47	BBRITW - Background Brightness (Whole)	I4
	48 - 52	BBRITD - Background Brightness (Decimal)	I5
	54 - 56	SUMOSH - Sun/Moon Shadow	I3
	58	FOLIAG - Foliage	I1
**	77 - 80	Sequential Card Identification- Never Read, Written, or Processed	I4

Cards 1 and 2 are repeated as many times as there are records. The last two cards of the deck are always:

COLUMNS	ITEM	FORMAT
1 - 5	Termination Card (Nines) and a blank card	99999

2.5.5 Retrieval Option Card

COLUMNS	ITEM	FORMAT
1	Retrieved Records on Input-Formatted Punched Cards (IPUNCH).	I1
2	Retrieved Records with Case Number on Blocked, Input-Formatted Magnetic Tape (IKEEP). Required for correlation input.	I1
FOR EACH	{ 0 = Do not perform the option 1 = Perform the option	

In each case the case number is printed followed by a one-line print out of the retrieved record.

2.5.6 Search Parameter and Interval Card Set

COLUMNS	ITEM	FORMAT
1 - 6	Search Parameter (INAM)	A6
7 - 9	Last Card Set (IEND)-Right justified. Used only after last search set for each user group.	
12 - 21	1 Lower Limit of Interval-Right Justified	
12 - 21	2 Lower Limit of Whole Part of Word-Right Justified	
24 - 33	1 Upper Limit of Interval-Right Justified	
24 - 33	2 Lower Limit of Decimal Part of Word	
36 - 45	2 Upper Limit of Whole Part of Word	
48 - 57	2 Upper Limit of Decimal Part of Word	

The 2 indicates the item description when the intervals are represented by words of 7 character length or more; such as, standard brightness and background brightness, each of which contains 9 characters (four whole number digits and 5 decimal digits).

The above card represents "one" specification of a possible 35 available for retrieval of each "Project UNDERBRUSH" record stored on magnetic tape. For example, a typical search may involve location of all entries in June 1968, between 1830 and 2230 (local time) that only include clouds over 3,000 feet and a south wind. The series of cards to describe such a case are:

WINDIR	S	S
CLHITE	3	99
LOCTIM	1830	2230
IDATE	680601	680630

As illustrated in the card deck set-up in the event that multiple retrieval operations are requested, a blank card is used to separate each set of search cards. There may be as many as ten such sets within each user group, however, the last set must be terminated not with a blank card, but by a card containing characters as follows:

COLUMNS	ITEM	FORMAT
1 - 6	Terminal Nines, 999999	A6
9	Last User Group Flag (IEND)- Right Justified	I3

IEND = 0, There are more user groups of search criteria to examine

IEND = 1, There are no more user groups to examine, return.

CORRELATION REQUEST CARD

COLUMNS	ITEM	FORMAT
1 - 2	Case Number of Retrieved Records to be used in Correlation (ICASE)	I2
7 - 12	Abscissa of Correlation (IABS)	A6
14 - 19	Ordinate of Correlation (IORD)	A6
25	0, There are more cases to be correlated-continue in the correlation cycle.	

1, There are no additional cases to be correlated, end the computation.

3. COMATAN

3.1 Summary

This routine controls the main logic of the Computer Assisted Target Analysis Program.

3.2 Restrictions/Assumptions

As many as two magnetic tape units, a card reader, and a printer must be available for use of this routine.

3.3 Options

There are five execution options:

1. Store only
2. Store & retrieve
3. Store, retrieve and correlate
4. Retrieve only
5. Retrieve and correlate.

3.4 Method

This program first reads a control card of three flags to determine the program phases to use on a particular execution. Only a one (1) in the proper place designates use of a phase. The first test is for use of the storage phase of the program. If affirmed, a message, "MOUNT USED TAPE ON UNIT 1, NEW ON UNIT 2," to prepare for the storage routine options is printed.

NOTE: "USED" refers to

1. A blank tape onto which card images will be stored.

2. A tape containing some card images to be copied onto unit 2 and added there.

3. A completed tape of card images to be copied onto unit 2 for "housekeeping" purposes.

After subroutine STORE is called a message, "FINISHED THE STORAGE PHASE - DATA ON UNIT ___," to identify the location of the most recently stored data is printed. Then the retrieval phase is tested for use. If the test is negative, execution stops. If positive, the correlation phase is executed and "FINISHED CORRELATION PHASE" is printed. This is the program termination. However, in event that the storage phase is not elected for execution, a message, "MOUNT DATA TAPE ON UNIT 1," is written, the value one (1) is assigned to the tape unit name, and the retrieval phase flag is tested for use. Here, if RETRIV is not elected, execution stops. If it is elected, the argument control card is read as input to RETRIV. After RETRIV is called and executed "FINISHED RETRIEVAL PHASE" is written and the correlation phase is tested for use. If negative, terminate execution. If positive, execute CORREL, write termination message and end.

3.5 Calling Sequence

None.

3.6 Common Storage

None.

3.7 Subroutines Required

STORE

RETRIV

CORREL

3.8 Accuracy

Single precision floating point word.

3.9 Error Messages

None.

3.10 Input Format

The subroutine option card must be read in the following format:

COLUMN	ITEM	FORMAT
1	Flag for use of storage phase	I1
2	Flag for use of retrieval phase	I1
3	Flag for use of correlation phase	I1

A one (1) represents use of the phase; a zero (0) represents non-use of the phase.

If the storage phase is not used and the retrieval phase is required, a card must be read to define the calling sequence of subroutine RETRIV. All items are to be right justified.

COLUMN	ITEM	FORMAT
1	Tape unit number on which the "Project UNDERBRUSH" data tape (ITAPE) is to be placed for use. This is unit 1.	I1

2 - 5	The number of completely filled blocks of data (IPABC1) on that tape.	I4
6 - 7	The number of two-card data sets in the unfilled block (IPABC2).	I2

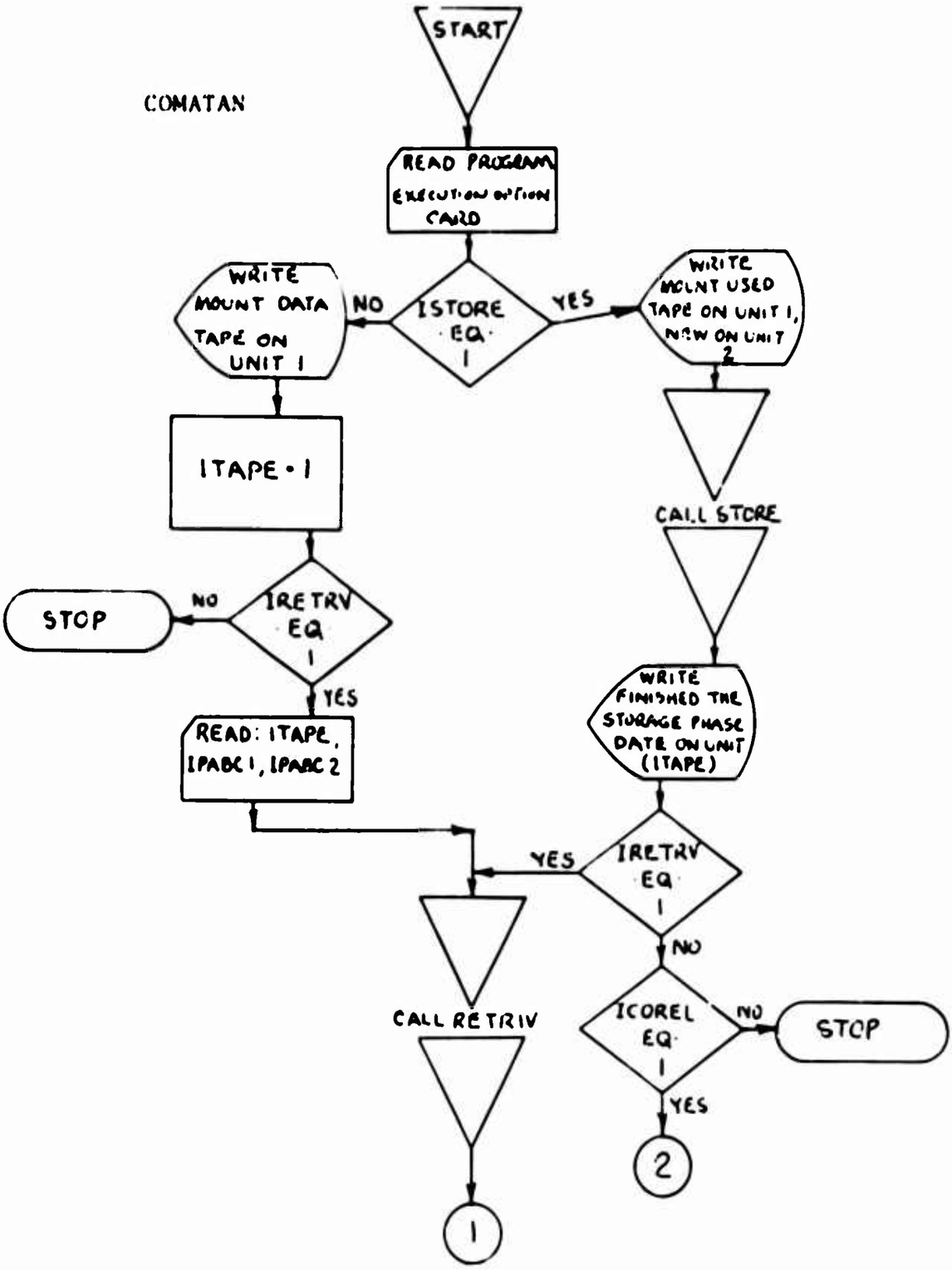
The values of IPABC1 and IPABC2 are printed during any execution of the storage phase of the program. These values may be copied and applied to the above-mentioned calling sequence control card.

3.11 Output Format

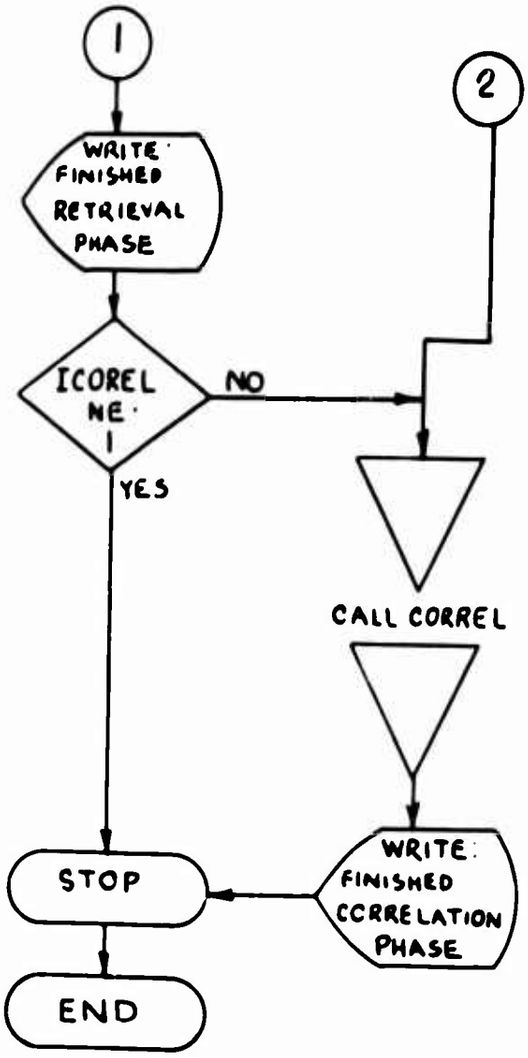
The following on-line printouts may occur depending upon the mode of operation.

1. Mount data tape on unit 1
2. Mount used tape on unit 1, new on unit 2
3. Finished the storage phase - data on unit ___
4. Finished retrieval phase
5. Finished correlation phase.

COMATAN


START
READ PROGRAM EXECUTION OPTION CARD
ISTORE EQ 1
NO
YES
WRITE MOUNT DATA TAPE ON UNIT 1
WRITE MOUNT USED TAPE ON UNIT 1, NOW ON UNIT 2
ITAPE = 1
CALL STORE
IRETRV EQ 1
NO
STOP
YES
READ: ITAPE, IPABC 1, IPABC 2
WRITE FINISHED THE STORAGE PHASE DATA ON UNIT (ITAPE)
IRETRV EQ 1
YES
NO
CALL RETRIV
ICOREL EQ 1
NO
STOP
YES
2
1

COMATAN


1
2
WRITE FINISHED RETRIEVAL PHASE
ICOREL NE 1
NO
YES
CALL CORREL
WRITE FINISHED CORRELATION PHASE
STOP
END

4. STORE

4.1 Summary

This subroutine stores "Project UNDERBRUSH" records on tape with record addition and protection options.

4.2 Restrictions/Assumptions

The original source document data must be converted into a machine readable form. The encoded data for each set must appear in two-card sets. One or two magnetic tapes are required for this subroutine depending upon the option used.

4.3 Options

It makes provisions to store the data initially onto tape from cards or copy the previously stored data from an original tape to a new tape and add any new data to the resultant tape. Since tape records are so easily damaged, all data stored on a tape should be copied onto fresh tape periodically.

4.4 Method

This subroutine reads the storage option card and branches to execute. The data are handled in blocks of 10 two-card sets for optimum use of tape. At the end of each option the number of filled blocks (IPABC1) on tape and the number of two-card sets in the unfilled block (IPABC2) are reported. The tapes are then rewound and the execution continues.

Provision is made in this subroutine to distinguish between a wind speed reading of zero miles per hour versus a case

where no wind speed reading was made (a blank). A two-character Hollerith letter, IB, is used to designate a blank wind speed field.

4.5 Calling Sequence

This subroutine is called by:

CALL STORE (ITAPE, IPABC1, IPABC2)

Where,

ITAPE = the tape unit on which the data tape finally appears,

IPABC1= the number of completely filled blocks of data on tape,

IPABC2= the number of two-card data sets in the unfilled block.

4.6 Common Storage

None.

4.7 Subroutines Required

None.

4.8 Accuracy

Single precision floating point word.

4.9 Error Messages

Only one error message may appear for this subroutine. In the event that a character other than 0, 1, or 2 appears for the storage option control (IRUN), this message will result:

"STORAGE OPTION CONTROL (IRUN) CONTAINS AN
ILLEGAL INTEGER CONSTANT"

and the integer constant will be printed.

4.10 Input Format

Input is provided to the routine through cards or tape or tape and cards. The card input format is as follows:

CARD 1 - STORAGE OPTION CARD

COLUMN	ITEM	FORMAT
1	Storage option (IRUN)	Integer

IRUN = 0, store data initially - read and store initial data from card to tape with a terminal entry of nines.

IRUN = 1, copy tape, add data - read old tape data onto a new tape, sense terminal entry, add new data from card to new tape, and apply terminal nines.

IRUN = 2, copy tape - copy data from old to new tape as a "housekeeping" exercise for protection of tape-stored data.

CARD SET 2 - ENCODED "UNDERBRUSH" DATA

CARD 1

COLUMNS	ITEM	FORMAT
1 - 5	Mission Name	A5
6 - 9	Mission Number	A4

11	Sensor Type	I1
13 - 14	Sensor Designation	I2
16 - 21	Date	I6
23 - 25	Aircraft	I3
27	Location	I1
29 - 32	Sunrise	I4
34 - 37	Sunset	I4
39 - 42	Moonrise	I4
44 - 47	Moonset	I4
49 - 52	Time (Local)	I4
54	Sky Cover	I1
56 - 57	Height (Clouds)	I2
59	Type (Clouds)	I1
61 - 62	Wind Direction	A2
64 - 65	Wind Speed (Knots)	A2
67 - 68	Weather Status	A2
70 - 72	Wet Bulb (F)	I3

CARD 2

COLUMNS	ITEM	FORMAT
1 - 3	Dry Bulb (F)	I3
5 - 7	Relative Humidity %	I3
9 - 11	Solar Radiation	I3
13	Precipitation	A1
15	Ground Visibility	I1
17 - 18	Dew Point (F)	I2
20 - 22	Reference Cube	I3

24 - 26	Background Results	I3
28 - 30	Background Temperature (C)	I3
32	Moon Phase	I1
34 - 42	Standard Brightness	I9
44 - 52	Background Brightness	I9
54 - 56	Sun/Moon Shadow	I3
58	Foliage	I1

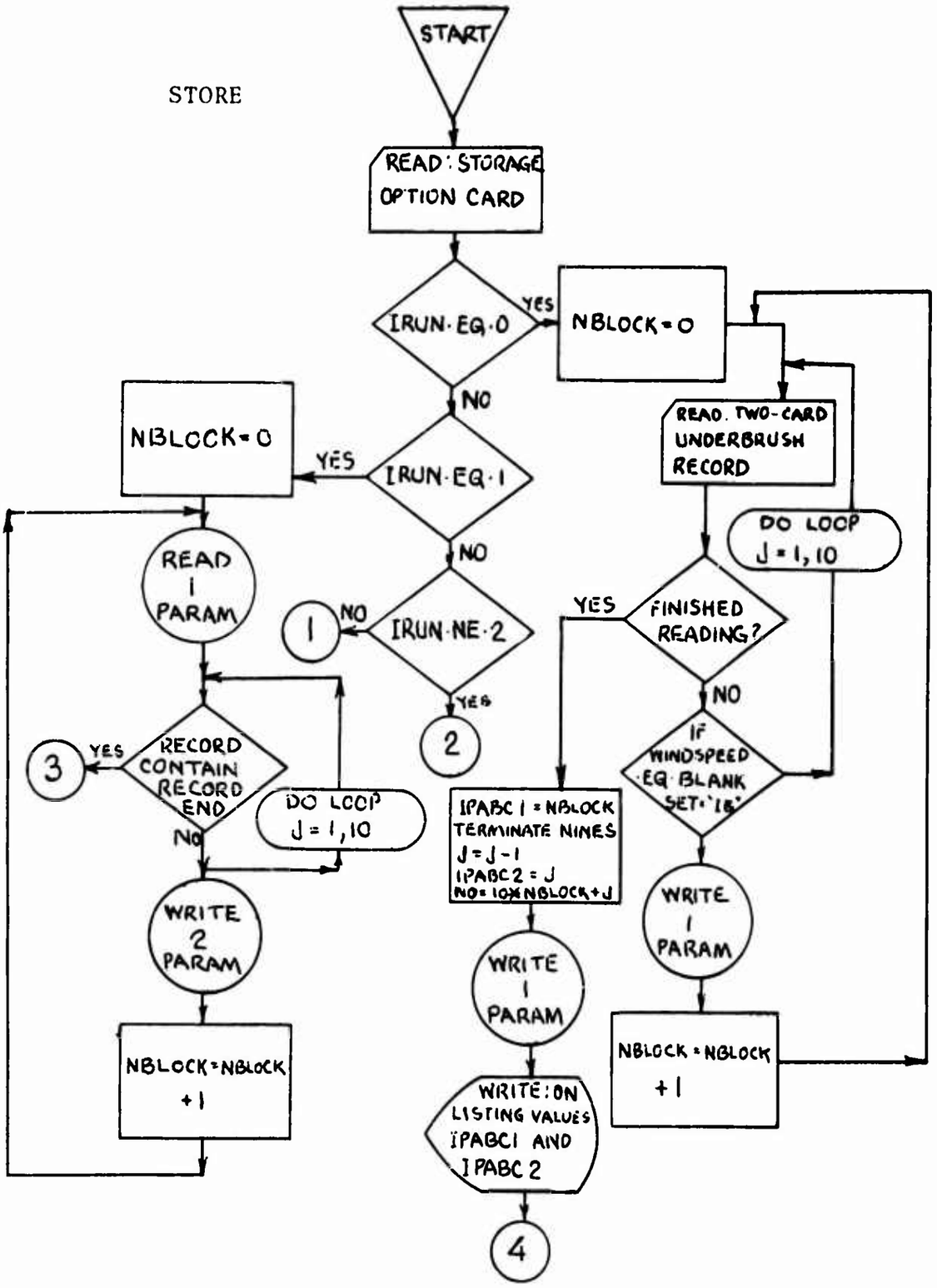
There may be as many of the two-card sets as necessary to complete the data available. This set of cards must be terminated by these two cards:

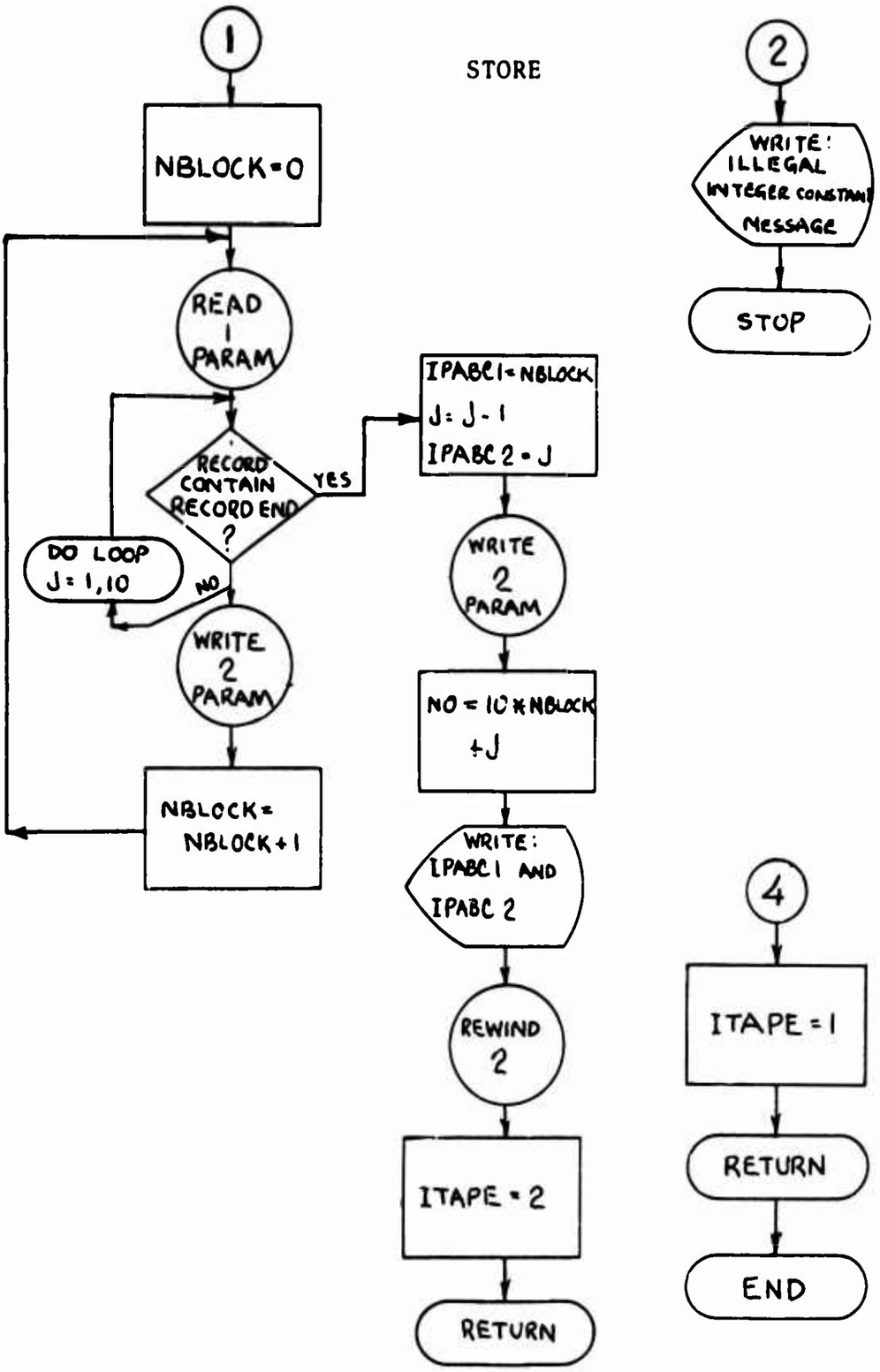
	COLUMN	ITEM	FORMAT
CARD 1	1 - 5	99999 Termination	A5
CARD 2	1 - 80	Blank	--

4.11 Output Format

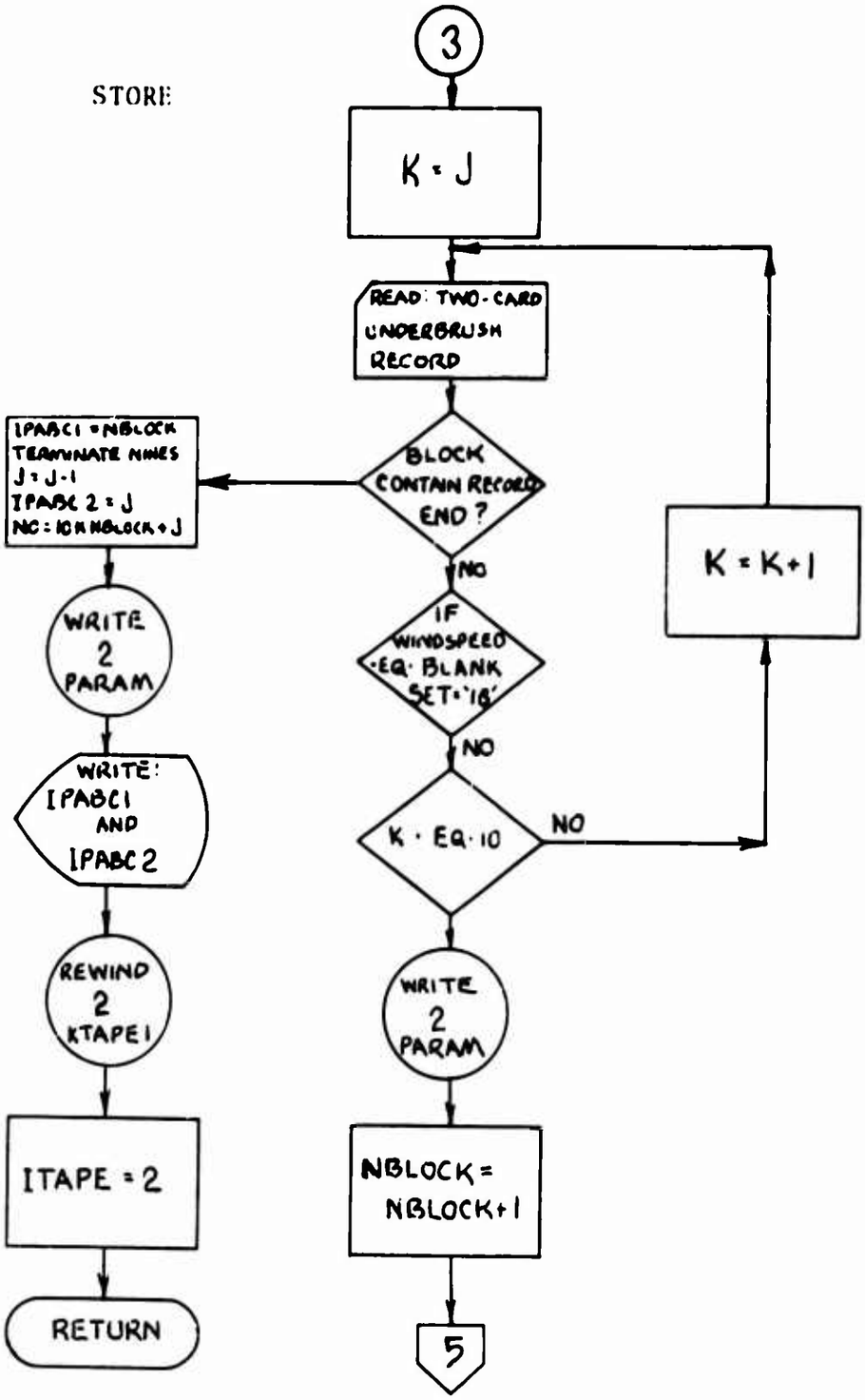
Output occurs on magnetic tape in card image blocks of ten two-card data sets per filled block. The number of completely filled blocks of data stored on tape (IPABC1) and the number of two-card data sets in the unfilled block (IPABC2) are then printed. A terminal entry of 9999 appears at the end of the records.

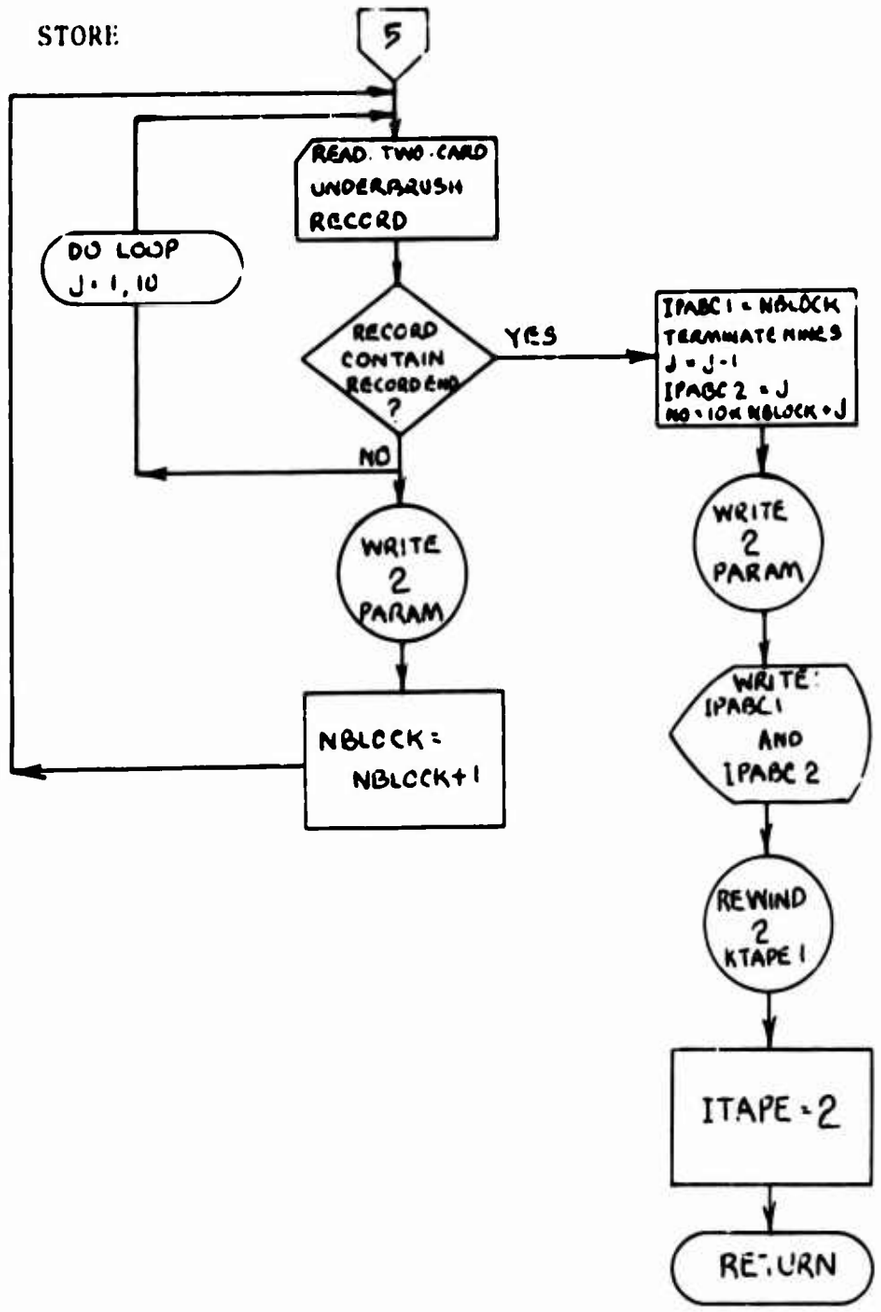
STORE


START
READ: STORAGE OPTION CARD
IRUN·EQ·0
YES
NBLOCK=0
NO
NBLOCK=0
YES
IRUN·EQ·1
NO
READ TWO-CARD UNDERBRUSH RECORD
DO LOOP J=1,10
READ 1 PARAM
1
NO
IRUN·NE·2
YES
2
YES
FINISHED READING?
NO
3
YES
RECORD CONTAIN RECORD END
NO
DO LOOP J=1,10
IF WINDSPEED ·EQ· BLANK SET='18'
IPABC1 = NBLOCK
TERMINATE NINES
J=J-1
IPABC2 = J
NO=10*NBLOCK+J
WRITE 2 PARAM
WRITE 1 PARAM
WRITE 1 PARAM
NBLOCK=NBLOCK+1
NBLOCK=NBLOCK+1
WRITE ON LISTING VALUES IPABC1 AND IPABC2
4


STORE
1
NBLOCK=0
READ 1 PARAM
RECORD CONTAIN RECORD END ?
YES
NO
DO LOOP J=1,10
WRITE 2 PARAM
NBLOCK= NBLOCK+1
IPABC1=NBLOCK
J=J-1
IPABC2=J
WRITE 2 PARAM
NO=10*NBLOCK +J
WRITE: IPABC1 AND IPABC2
REWIND 2
ITAPE=2
RETURN
2
WRITE: ILLEGAL INTEGER CONSTANT MESSAGE
STOP
4
ITAPE=1
RETURN
END

STORE:


3
K = J
READ TWO-CARD UNDERBRUSH RECORD
BLOCK CONTAIN RECORD END ?
IPABC1 = NBLOCK
TERMINATE NMES
J = J-1
IPABC 2 = J
NC = 10H NBLOCK + J
WRITE 2 PARAM
WRITE: IPABC1 AND IPABC2
REWIND 2 KTAPE1
ITAPE = 2
RETURN
NO
IF WINDSPEED .EQ. BLANK SET = '18'
NO
K . EQ. 10
NO
K = K+1
WRITE 2 PARAM
NBLOCK = NBLOCK+1
5


STORE
5
READ TWO CARD UNDERFLOW RECORD
DO LOOP J = 1, 10
RECORD CONTAIN RECORDEND ?
YES
NO
IPABC1 = NBLOCK
TERMINATE NMLS
J = J-1
IPABC2 = J
NO = 10 * NBLOCK + J
WRITE 2 PARAM
NBLOCK = NBLOCK+1
WRITE 2 PARAM
WRITE IPABC1 AND IPABC2
REWIND 2 KTAPE1
ITAPE = 2
RETURN

5. RETRIV

5.1 Summary

This subroutine performs a search of the data stored on magnetic tape to permit access to all of the information containing a given data attribute.

5.2 Restrictions/Assumptions

This subroutine assumes input from magnetic tape of "UNDERBRUSH" encoded data records and presence of a magnetic scratch tape.

5.3 Options

This subroutine has the option of punching all retrieved records for one or more users on cards in input format or writing on scratch tape all retrieved records with case number for correlation input. A documented list of all retrieved items will appear.

5.4 Method

There are four major arrays that are used to support the logic of this phase:

1. PARAM (35,10) = Project Underbrush encoded data handled in blocks of ten records to optimize use of memory and tape length.

2. NAME (35) = Name of each item in the Project Underbrush encoded data as established in a Fortran IV data statement.

3. ITABLE (5, 35, 10) = Search parameter and interval card set. The five represents one part search parameter and four parts interval in order to allow for the nine-digit brightness words. The ten allows for that many case requests per user.

4. ITALLY (3, 10) = Tally array where the first part holds a position for each case requested by one user up to ten positions. The second part holds a count of "and's" (condition) for each of the above cases and the third part holds a flag for each of the cases to indicate whether the interval's lower limit was found to be greater than its upper limit for any "and" (condition) of a case, thus necessitating deletion of the entire case in any subsequent searches.

The logic proceeds as follows:

Initialize the third (flag) position of ITALLY array.

Read the retrieval request card (IPUNCH, IKEEP).

Read the search parameters and intervals into ITABLE array in "or" blocks (cases) by the temporary storage on tape of each interval while determining it to be integer or alphanumeric data.

The item is then read back from tape and printed in format.

Maintain parts one and two of TALLY array.

Rewind scratch tape.

Initialize count of records on master Project "Underbrush" (P.U.) data tape.

Read a block (ten records) of P.U. data from tape.

Test to see if it is the last block on tape.

Test the first part of ITABLE record against all of NAME array. When a match is found, the index of the match position allows the corresponding index position to be located in PARAM array record in question.

The remaining four parts of ITABLE record (interval) are tested for content of PARAM item of record in question. If it is satisfied, return to ITABLE array for the second record and so on until the entire case has been satisfied at which time the retrieved record is output. If any condition is not satisfied by the PARAM record in question, the entire case is skipped and execution branches to the first

condition in the next case.

5.5 Calling Sequence

CALL RETRIV (ITAPE, IPABC1, IPABC2, MTAPE, KEEP)

Where,

ITAPE = the tape unit on which the data tape finally appears.

IPABC1= the number of completely filled blocks of data on tape.

IPABC2= the number of two-card data sets in the unfilled block.

MTAPE = the output tape of retrieved records and case numbers.

KEEP = the number of retrieved records on tape (MTAPE).

5.6 Common Storage

None.

5.7 Subroutines Required

BRITE

5.8 Accuracy

Single precision floating point word.

5.9 Error Messages

Two error messages may result from this subroutine:

"NO MATCH HAS BEEN FOUND FOR A6 - CASE I2 SEARCH PARAMETER I2 CHECK SPELLING"

occurs when the search parameter of a search criterion card is in the improper field or spelled incorrectly.

"LOWER LIMIT GREATER THAN UPPER LIMIT IN CASE I2 SEARCH PARAMETER I2,

THIS ENTIRE CASE WILL BE IGNORED"

occurs when limits of the search parameter on a search criterion card are inverted. The lower limit should appear before the upper limit on the criterion cards.

5.10 Input Format

Input is provided to the routine through cards and tape. The card input format is as follows:

CARD 1 - RETRIEVAL OPTION CARD

COLUMN	ITEM	FORMAT
1	Punch option (IPUNCH)	I1
2	Magnetic tape (IKEEP)	I1

CARD SET 1 - SEARCH PARAMETER AND SEARCH CRITERION SET

COLUMN	ITEM	FORMAT
1 - 6	Search parameter (INAM)	A6
7 - 9	Last set flag (IEND) Right justified	I3

12 - 21	1 Lower limit of interval Right justified	I10
	2 Lower limit of whole part of word	
24 - 33	1 Upper limit of interval Right justified	I10
	2 Lower limit of decimal part of word	
36 - 45	2 Upper limit of whole part of word	I10
48 - 57	2 Upper limit of decimal part of word	I10

Where the 2 indicates the item description when the intervals are represented by words of 7 character length or more; such as, standard brightness and background brightness each of which contains 9 characters (four whole number digits and 5 decimal digits).

The above card represents one "and" specification of a possible 35 available for retrieval of each "Project Underbrush" record stored on magnetic tape. For example, a typical search may involve location of all entries containing solar radiation values obtained under clear sky conditions. The series of cards to describe such a case are:

SOLRAD	1	200
SKYCOV	1	1

This card group must be terminated by a blank card. There may be as many as ten such groups within each set. The set must be terminated by a card containing characters as follows:

COLUMNS	ITEM	FORMAT
1 - 6	Terminal nines, 999999	A6
9	Last set flag (IEND) Right justified	I3

IEND = 0, there are more sets of search criteria to examine.

IEND = 1, there are no more sets of search criteria to examine, return.

A scratch tape is needed for temporary storage of the interval fields while the search parameter name is tested for specification of alpha or integer data. If the search parameter name is one that describes integer interval data, a single format is used to print out that name and its interval data. If the search parameter name is one that describes alpha interval data, one of four formats is used to print out that name and its interval data. They are as follows:

Write out one alpha character search criteria
two alpha character search criteria
three alpha character search criteria
four alpha character search criteria.

5.11 Output Format

Subroutine RETRIV outputs two initial messages:

"THIS IS THE RETRIEVAL PROGRAM"

"MOUNT DATA TAPE ON UNIT 1"

The search parameter and search criterion table is printed case-by-case. At this point, if any instance of lower interval limit greater than upper limit occurred within the table, the location is cited.

A title, "RETRIEVED RECORDS," is printed as a page heading with six lines of 132 Hollerith characters giving the five or six character names describing each item in the "Project Underbrush" data. These names are printed vertically atop the column of data they describe. Before each retrieved record is printed appears the case number to which the retrieval applies. A retrieved record appears on a single printed line in the following format:

COLUMNS	ITEM	ABBREVIATED NAME	FORMAT
2 - 6	Mission Name	MISNAM	A5
7 - 10	Mission Number	MISNUM	A4
12	Sensor Type	SENTYP	I1
14 - 15	Sensor Designation	SENDES	I2
17 - 22	Date	IDATE	I6
24 - 26	Aircraft	AIRCRF	A3
28	Location	LOCAT	A1
30 - 33	Sunrise	SUNRIZ	I4
35 - 38	Sunset	SUNSET	I4
40 - 43	Moonrise	MUNRIZ	I4
45 - 48	Moonset	MUNSET	I4
50 - 53	Time (Local)	LOCTIM	I4
55	Sky Cover	SKYCOV	I1

57 - 58	Height (Clouds)	CLHITE	I2
60	Type (Clouds)	CLTYPE	I1
62 - 63	Wind Direction	WINDIR	A2
65 - 66	Wind Speed (Knots)	WINSPD	A2
68 - 69	Weather Status	WESTAT	A2
71 - 73	Wet Bulb (F)	WETBUB	I3
75 - 77	Dry Bulb (F)	DRYBUB	I3
79 - 81	Relative Humidity %	RELHUM	I3
83 - 85	Solar Radiation	SOLRAD	I3
87	Precipitation	PRECIP	A1
89	Ground Visibility	GRDVIS	I1
91 - 92	Dew Point (F)	DEWPTF	I2
94 - 96	Reference Cube	REFCUB	I3
98 - 100	Background Results	BGRRES	I3
102- 104	Background Temp (C)	BGRTEM	I3
106	Moon Phase	MUNPHA	I1
108- 116	Standard Brightness	STBRIT	I9
118- 126	Background Brightness	BGBRIT	I9
128- 130	Sun/Moon Shadow	SUMOSH	I3
132	Foliage	FOLIAG	I1

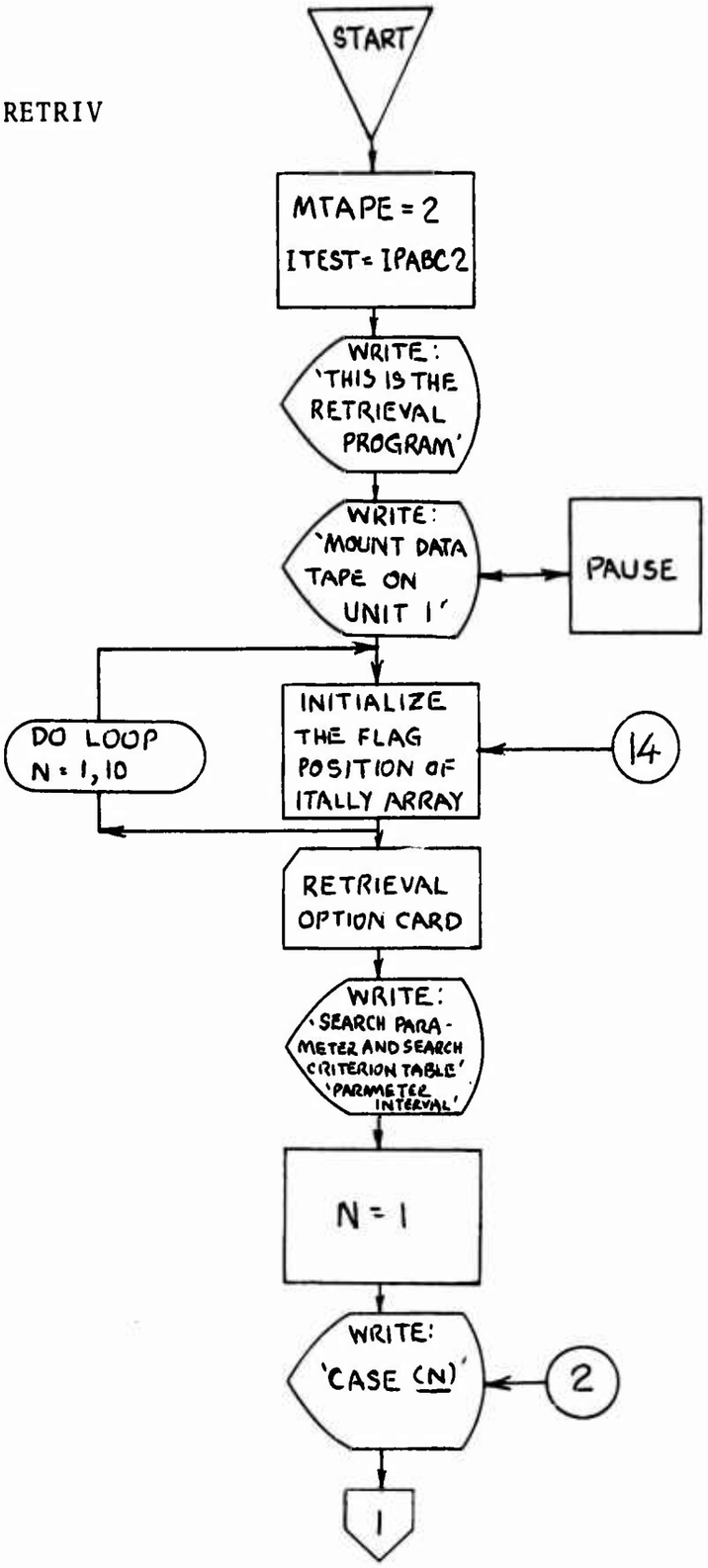
The use of the "punch" option allows the cases of anyone or all users to be punched in the two-card original input format to subroutine STORE.

The use of the "keep" option allows the case number plus record satisfying it to be written onto magnetic tape in the following format:

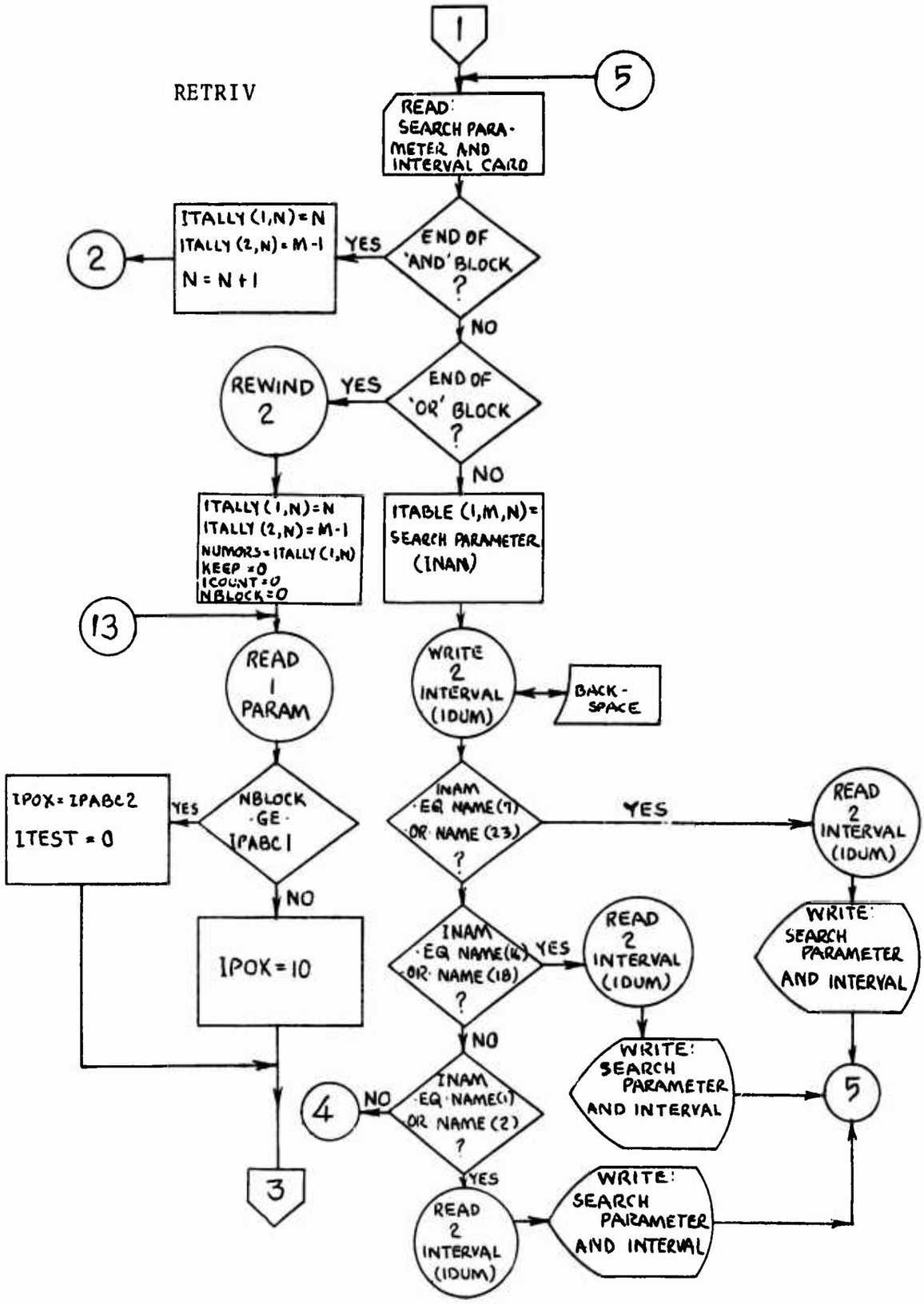
WORD	ITEM	FORMAT
1	Case number of retrieved record	I2
2	Mission name	A5
3	Mission number	A4
4	Sensor type	I1
5	Sensor designation	I2
6	Date	I6
7	Aircraft	A3
8	Location	A1
9	Sunrise	I4
10	Sunset	I4
11	Moonrise	I4
12	Moonset	I4
13	Local time	I4
14	Sky cover	I1
15	Height (clouds)	I2
16	Type (clouds)	I1
17	Wind direction	A2
18	Wind speed	A2
19	Weather status	A2
20	Wet bulb	I3
21	Dry bulb	I3
22	Relative humidity	I3
23	Solar radiation	I3
24	Precipitation	I1
25	Ground visibility	I2

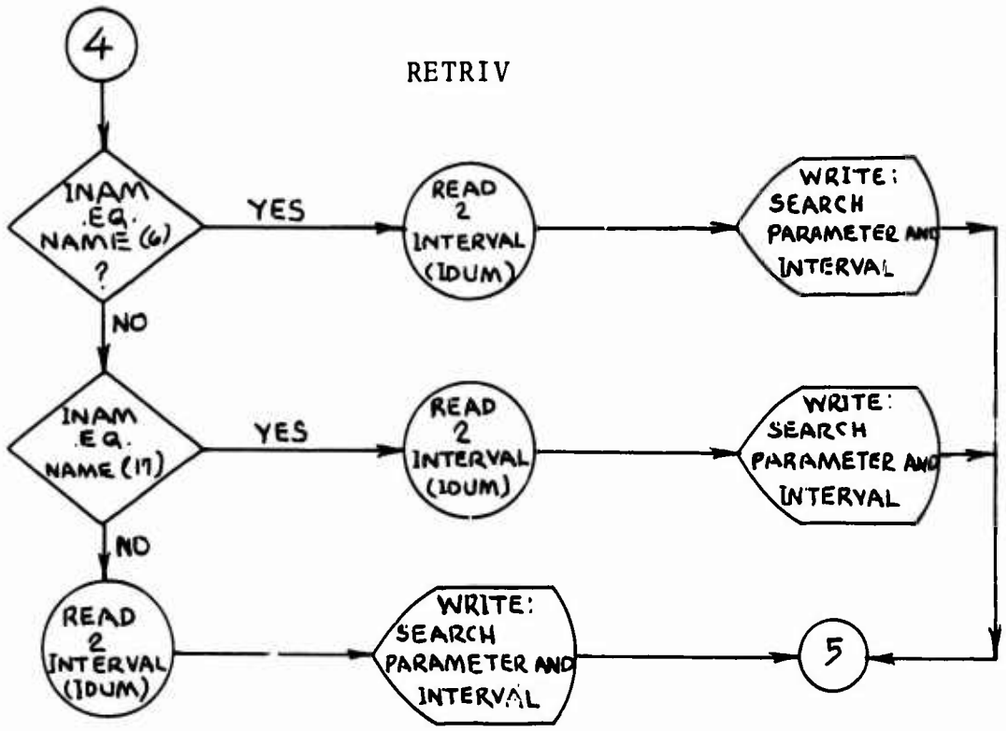
26	Dew point	I3
27	Reference cube	I3
28	Background results	I3
29	Background temperature	I1
30	Moon phase	I4
31	Standard brightness	I9
32	Background brightness	I9
33	Sun/Moon shadow	I3
34	Foliage	I1

RETRIV

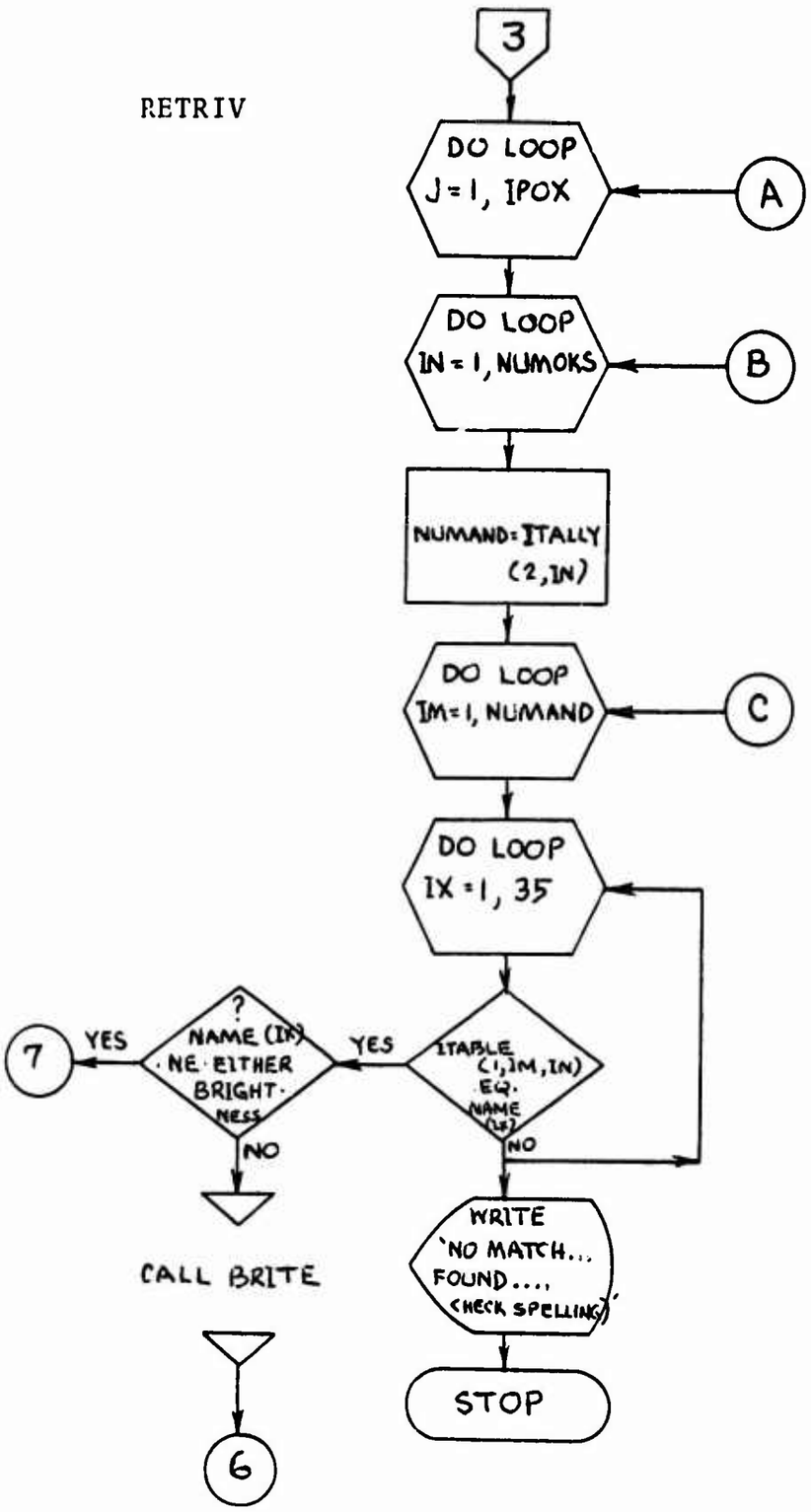

START
MTAPE = 2
ITEST = IPABC2
WRITE: 'THIS IS THE RETRIEVAL PROGRAM'
WRITE: 'MOUNT DATA TAPE ON UNIT 1'
PAUSE
DO LOOP N = 1, 10
INITIALIZE THE FLAG POSITION OF ITALLY ARRAY
14
RETRIEVAL OPTION CARD
WRITE: 'SEARCH PARAMETER AND SEARCH CRITERION TABLE' 'PARMETER INTERVAL'
N = 1
WRITE: 'CASE (N)'
2
1

RETRIV

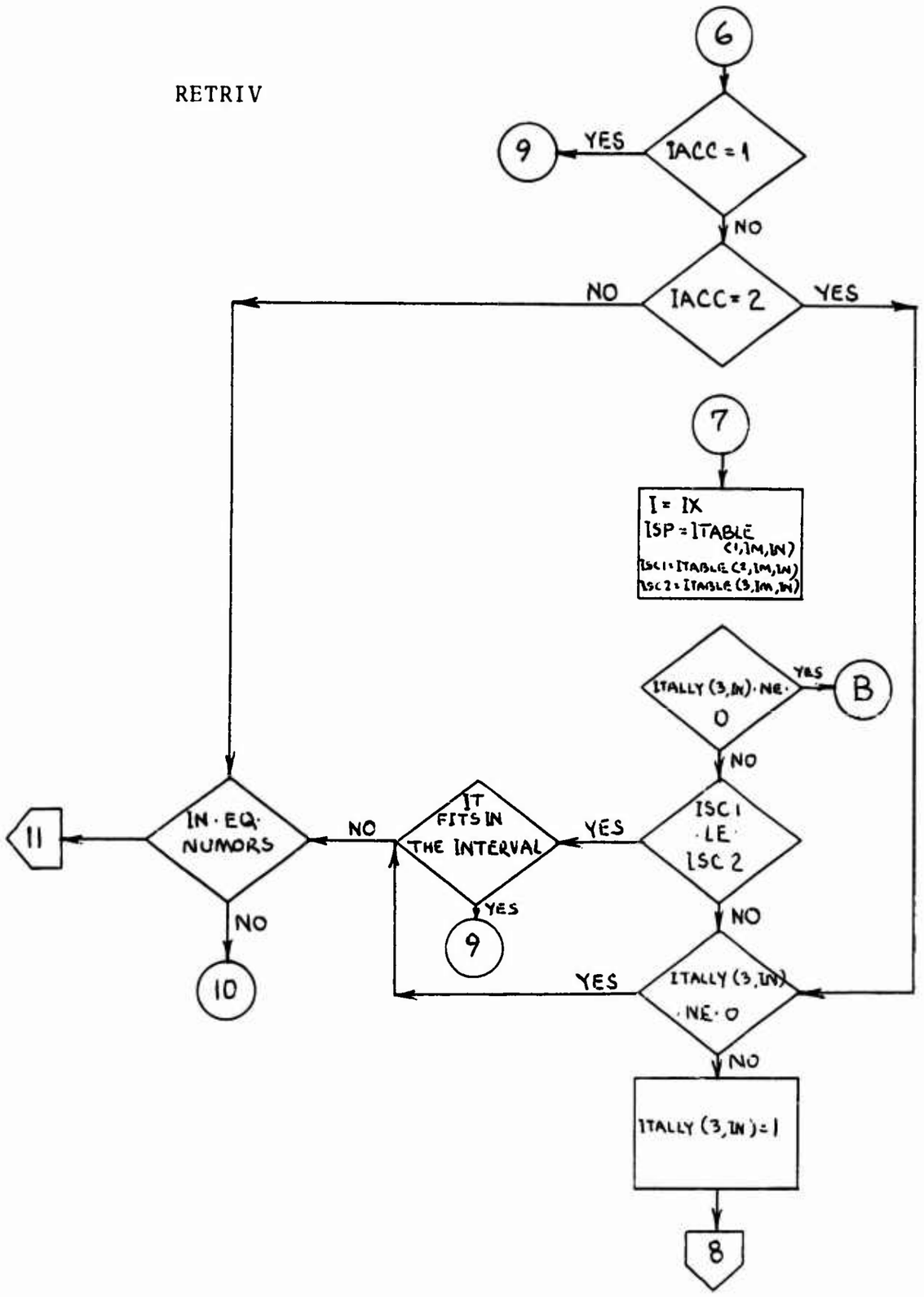

1
5
READ SEARCH PARAMETER AND INTERVAL CARD
END OF 'AND' BLOCK ?
YES
ITALLY (1,N) = N
ITALLY (2,N) = M-1
N = N+1
2
NO
END OF 'OR' BLOCK ?
YES
REWIND 2
NO
ITALLY (1,N) = N
ITALLY (2,N) = M-1
NUMORS = ITALLY (1,N)
KEEP = 0
ICOUNT = 0
NBLOCK = 0
ITABLE (I,M,N) = SEARCH PARAMETER (INAM)
13
READ 1 PARAM
WRITE 2 INTERVAL (IDUM)
BACK-SPACE
NBLOCK .GE. IPABC1
YES
IPOX = IPABC2
ITEST = 0
NO
IPOX = 10
INAM .EQ. NAME(7) .OR. NAME(23) ?
YES
READ 2 INTERVAL (IDUM)
WRITE SEARCH PARAMETER AND INTERVAL
INAM .EQ. NAME(4) .OR. NAME(18) ?
YES
READ 2 INTERVAL (IDUM)
WRITE SEARCH PARAMETER AND INTERVAL
NO
INAM .EQ. NAME(1) .OR. NAME(2) ?
NO
4
YES
READ 2 INTERVAL (IDUM)
WRITE SEARCH PAIRAMETER AND INTERVAL
3


4
INAM .EQ. NAME (6) ?
YES
READ 2 INTERVAL (IDUM)
WRITE: SEARCH PARAMETER AND INTERVAL
NO
INAM .EQ. NAME (17)
YES
READ 2 INTERVAL (IDUM)
WRITE: SEARCH PARAMETER AND INTERVAL
NO
READ 2 INTERVAL (IDUM)
WRITE: SEARCH PARAMETER AND INTERVAL
5

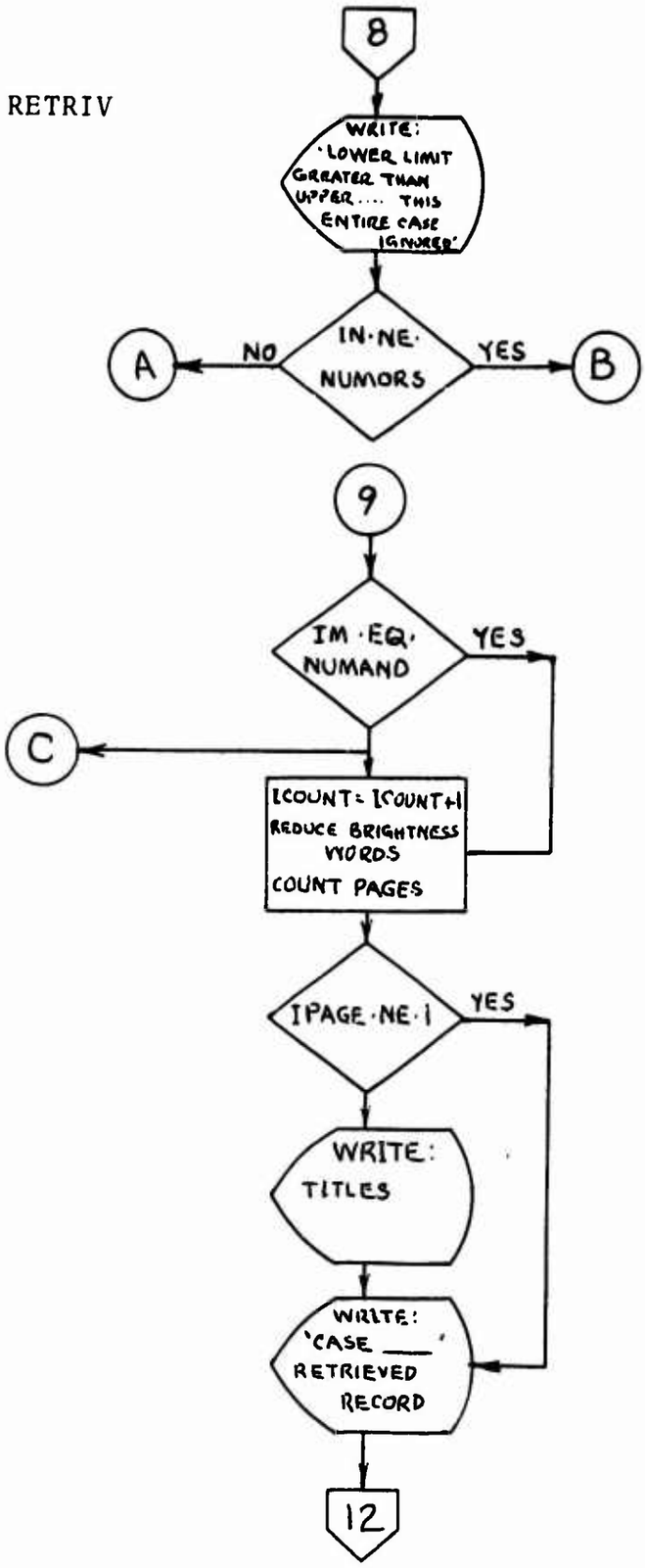
RETRIV


3
DO LOOP
J = 1, IPOX
A
DO LOOP
IN = 1, NUMOKS
B
NUMAND = ITALLY
(2, IN)
DO LOOP
IM = 1, NUMAND
C
DO LOOP
IX = 1, 35
ITABLE
(1, IM, IN)
EQ.
NAME
(IX)
YES
?
NAME (IX)
NE EITHER
BRIGHT-
NESS
YES
7
NO
NO
WRITE
'NO MATCH...
FOUND...,
CHECK SPELLING'
STOP
CALL BRITE
6

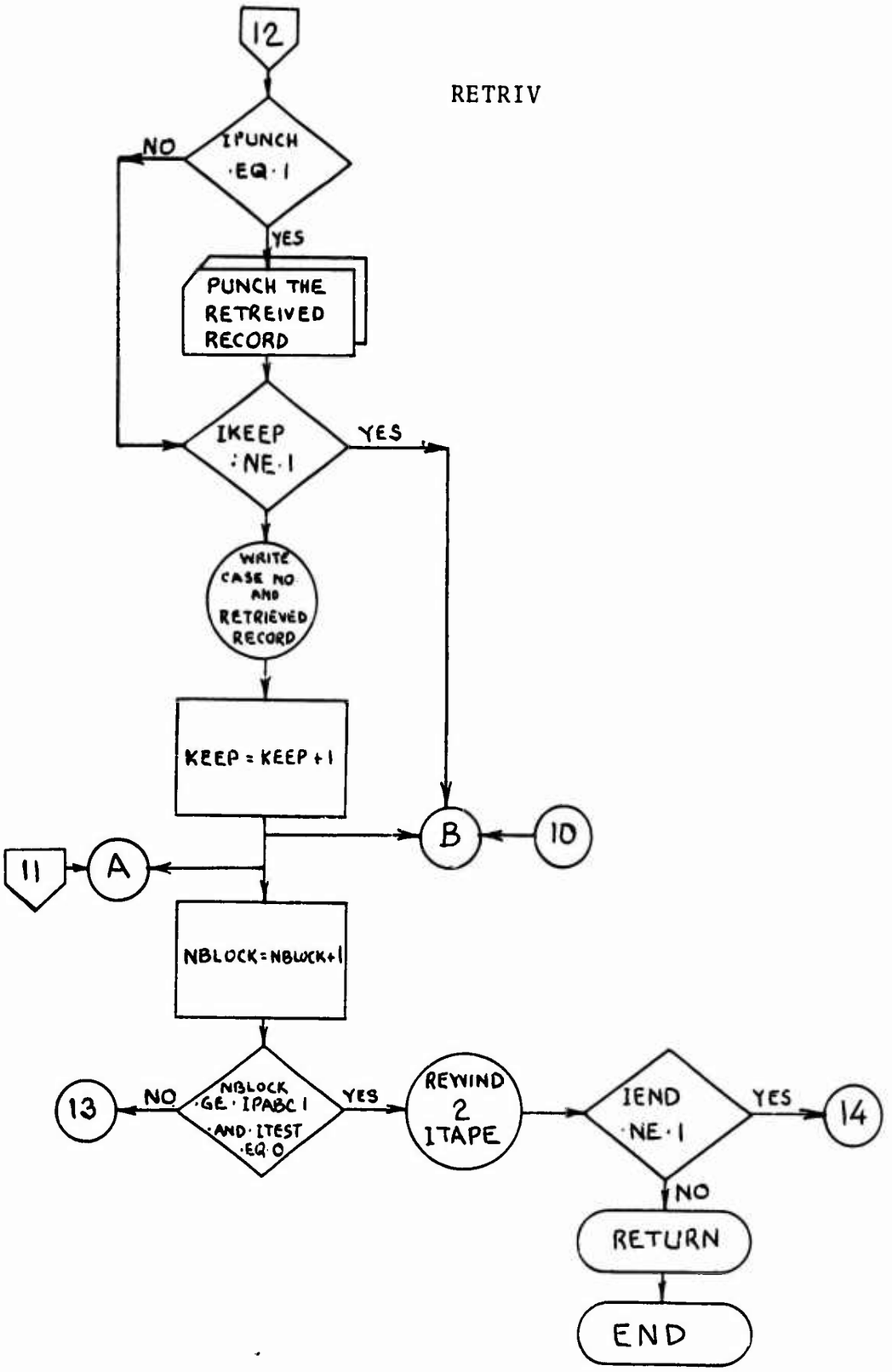
RETRIV


6
9
YES
IACC = 1
NO
NO
IACC = 2
YES
7
I = IX
ISP = ITABLE (1,IM,IN)
ISC1 = ITABLE (2,IM,IN)
ISC2 = ITABLE (3,IM,IN)
ITALLY (3,IN) .NE. 0
YES
B
NO
ISC1 .LE. ISC2
YES
IT FITS IN THE INTERVAL
NO
IN . EQ. NUMORS
11
NO
10
YES
9
NO
ITALLY (3,IN) .NE. 0
YES
NO
ITALLY (3,IN) = 1
8

RETRIV


8
WRITE:
'LOWER LIMIT GREATER THAN UPPER.... THIS ENTIRE CASE IGNORED'
IN.NE.
NUMORS
NO
YES
A
B
9
IM.EQ.
NUMAND
YES
C
ICOUNT=ICOUNT+1
REDUCE BRIGHTNESS WORDS
COUNT PAGES
IPAGE.NE.1
YES
WRITE:
TITLES
WRITE:
'CASE ____'
RETRIEVED
RECORD
12

RETRIV


12
IPUNCH .EQ. 1
NO
YES
PUNCH THE RETREIVED RECORD
IKEEP .NE. 1
YES
WRITE CASE NO AND RETRIEVED RECORD
KEEP = KEEP + 1
B
10
11
A
NBLOCK=NBLOCK+1
13
NO
NBLOCK .GE. IPABC 1 .AND. ITEST .EQ. 0
YES
REWIND 2 ITAPE
IEND .NE. 1
YES
14
NO
RETURN
END

6. BRITE

6.1 Summary

This subroutine handles interval tests on integer words which exceed six digits and have been divided into two words of six or less digits each.

6.2 Restrictions/Assumptions

None.

6.3 Options

None.

6.4 Method

Essentially two tests are performed in this subroutine:

1. Limit Test
   a. Test if lower limit whole number part is greater than the upper limit whole number part.
   b. Test if lower decimal part is greater than the upper limit decimal part.

2. Interval Test
   a. Test if whole number part of brightness word falls between the limits of the interval.
   b. Test if decimal part of brightness word falls between the limits of the interval.

6.5 Call BRITE (ISTOW, ISRCH, IACC)

Where,

ISTOW = The "Project Underbrush" brightness data stored on tape; dimensioned 2 where,

ISTOW (1) = the whole number part of the word

ISTOW (2) = the decimal part of the word

ISRCH = The interval limits from the search parameter and search criterion table; dimensioned 4 where,

ISRCH (1) = lower limit whole number

ISRCH (2) = lower limit decimal

ISRCH (3) = upper limit whole number

ISRCH (4) = upper limit decimal

IACC = A flag to return acceptance or rejection of parameter interval fit.

IACC = 1, means that both the whole number and decimal parts of a nine character brightness value fall between their respective search criterion limits *** accept.

IACC = 0, means that the above was not satisfied *** no accept.

IACC = 2, means that the whole number and/or the decimal part of the search

criterion interval is greater than the whole number and/or decimal part of the lower limit of the search criterion interval *** print, delete case.

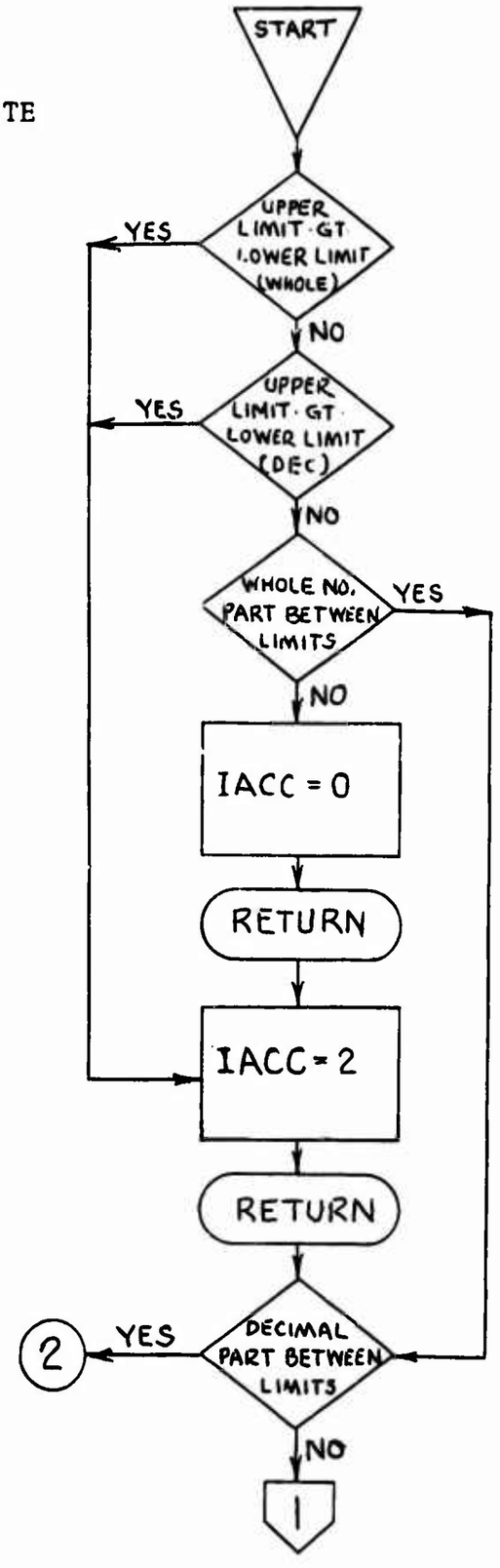
6.6 Common Storage

None.

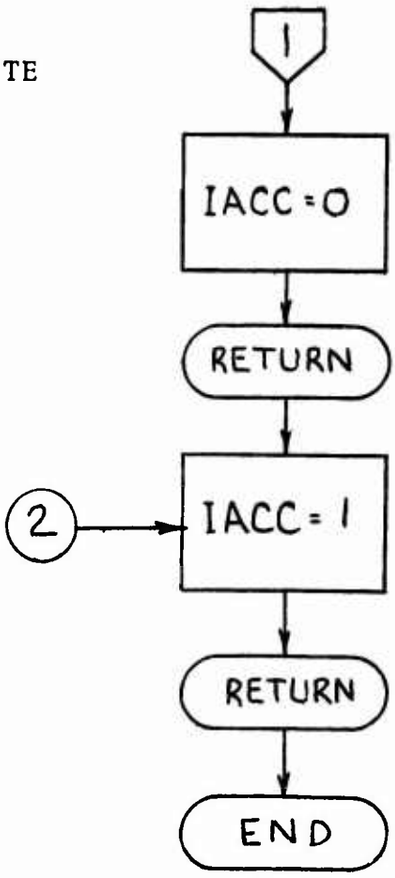
6.7 Subroutine Required

None.

BRITE


START
UPPER LIMIT GT LOWER LIMIT (WHOLE)
YES
NO
UPPER LIMIT GT LOWER LIMIT (DEC)
YES
NO
WHOLE NO. PART BETWEEN LIMITS
YES
NO
IACC = 0
RETURN
IACC = 2
RETURN
DECIMAL PART BETWEEN LIMITS
YES
2
NO
1

BRITE



7. CORREL

7.1 Summary

This subroutine performs a correlation between any two sets of attributes for which correlation is meaningful.

7.2 Restrictions/Assumptions

It is assumed that the magnetic tape input, generated by the IKEEP retrieval option, occurs through the retrieval phase.

7.3 Options

None.

7.4 Method

This subroutine reads a correlation request card containing the case number of the retrieved records to be used in correlation, the abscissa, and the ordinate of correlation. The name array is then searched for index positions of abscissa and ordinate and when they are found a magnetic tape of retrieved records is read. These records are tested for case number. As each pertinent case number is found, the abscissa and ordinate values are placed in array ICOORD in memory and counted. Subroutine MISR is called to calculate the means, variances, product-moment correlation coefficients, intercepts (A) and regression coefficients corresponding to the values of intercepts contained in the output matrix above (B). The equation Y=A+BX is solved for the regression line coordinates and plotted (PLOT).

In the event that more correlations based on the retrieval case are desired, execution branches to the beginning of the subroutine, rewinds the tape, and repeats execution.

7.5 Calling Sequence: CALL CORREL (MTAPE, KEEP)

Where,

MTAPE is the input magnetic tape of retrieved records from RETRIV

KEEP is the number of records on MTAPE.

7.6 Common Storage

None.

7.7 Subroutines Required

ARRAY, MISR, PLOT.

7.8 Accuracy

Single precision floating point word.

7.9 Error Messages

"YOU HAVE PROBABLY PICKED A CASE NUMBER WHICH HAS NO RETRIEVED RECORD ON TAPE"

is printed when the entire tape has been read and no case request has been satisfied.

7.10 Input Format

CORRELATION REQUEST CARD

COLUMN	ITEM	FORMAT
1	Case number of retrieved record to be used in correlation	I1

7 - 12	Abscissa	A6
14 - 19	Ordinate	A6
25	0, there are more cases to be correlated; continue in the correlation cycle. 1, there are no additional cases to be correlated; end the computation.	A1

RETRIEVED RECORD TAPE

WORD	ITEM	FORMAT
1	Case number of retrieved record	I2
2	Mission name	A5
3	Mission number	A4
4	Sensor type	I1
5	Sensor designation	I2
6	Date	I6
7	Aircraft	A3
8	Location	A1
9	Sunrise	I4
10	Sunset	I4
11	Moonrise	I4
12	Moonset	I4
13	Local time	I4
14	Sky cover	I1
15	Height (clouds)	I2
16	Type (clouds)	I1
17	Wind direction	A2

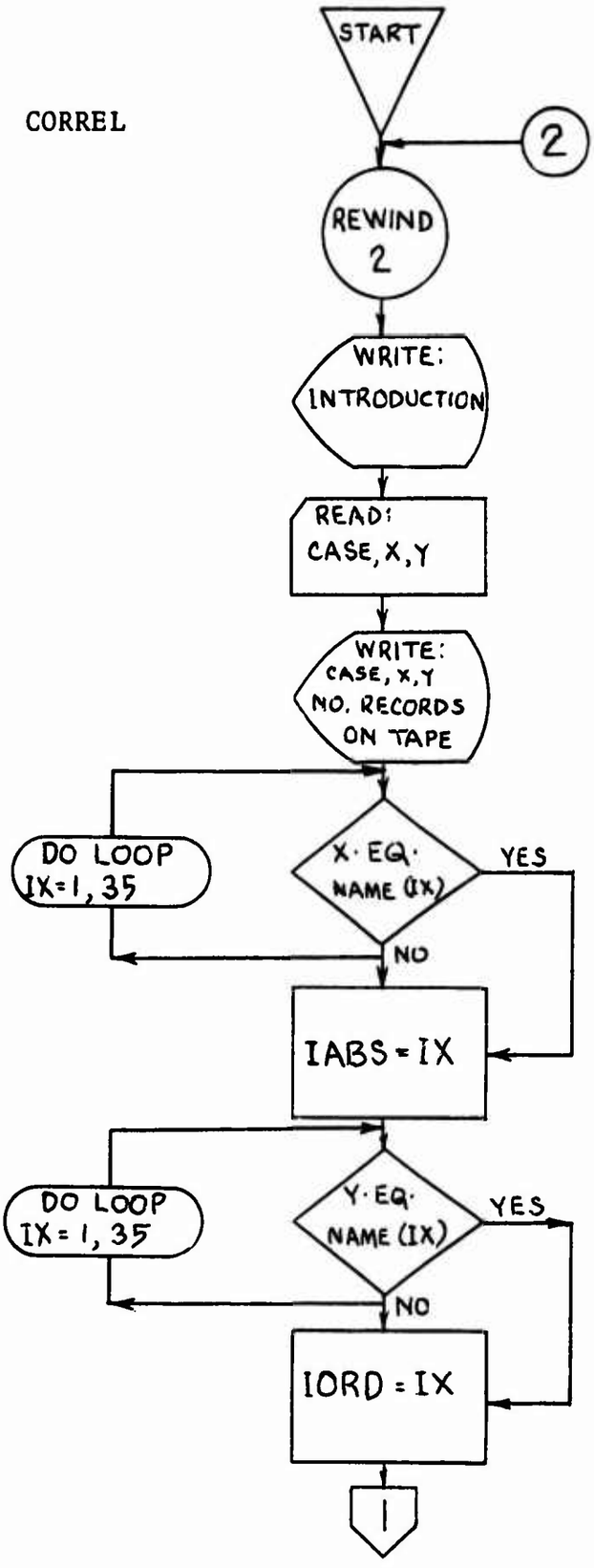
18	Wind speed	A2
19	Weather status	A2
20	Wet bulb	I3
21	Dry bulb	I3
22	Relative humidity	I3
23	Solar radiation	I3
24	Precipitation	I1
25	Ground visibility	I2
26	Dew point	I3
27	Reference cube	I3
28	Background results	I3
29	Background temperature	I1
30	Moon phase	I4
31	Standard brightness	I9
32	Background brightness	I9
33	Sun/moon shadow	I3
34	Foliage	I1

7.11 Output Format

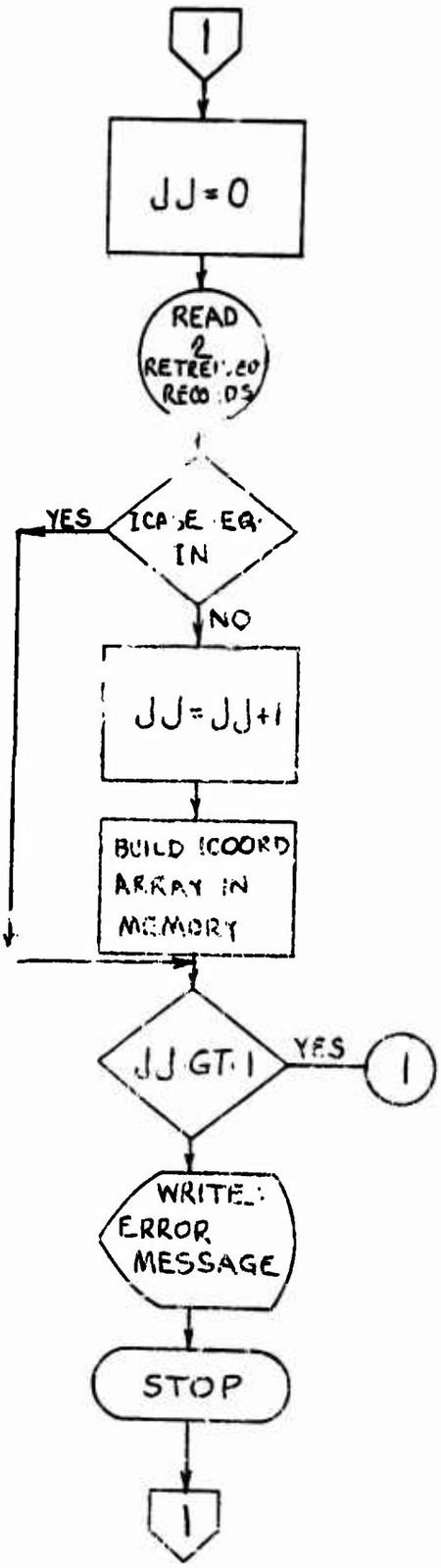
This subroutine outputs a computer listing containing:

1. Correlation request card information
2. Number of retrieved records on tape
3. X-mean and Y-mean
4. X-variance and Y-variance
5. Product-moment correlation coefficients
6. Table of regression line coordinates
7. Plot of the regression line.

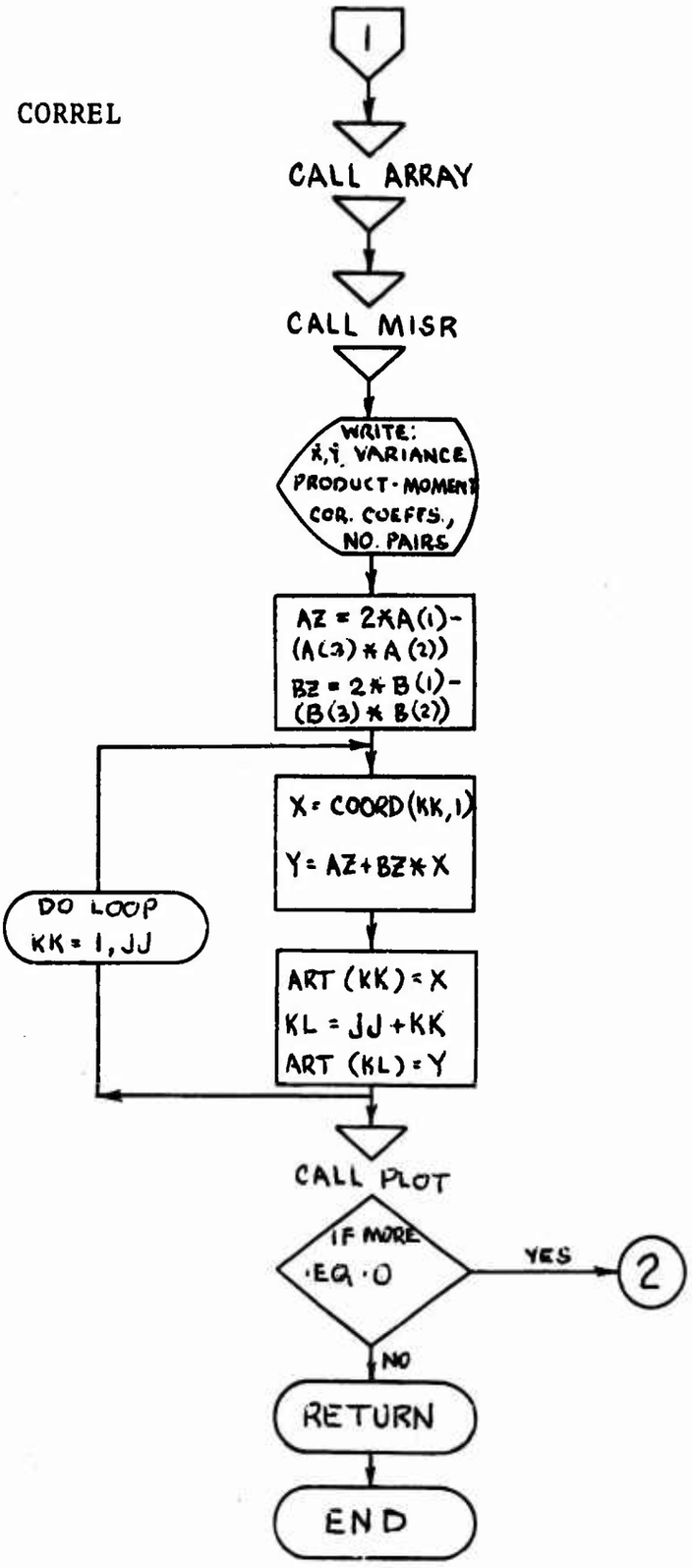
CORREL


START
2
REWIND 2
WRITE: INTRODUCTION
READ: CASE, X, Y
WRITE: CASE, X, Y NO. RECORDS ON TAPE
DO LOOP IX=1, 35
X·EQ· NAME (IX)
YES
NO
IABS = IX
DO LOOP IX = 1, 35
Y·EQ· NAME (IX)
YES
NO
IORD = IX
1

CORREL


1
JJ=0
READ 2 RETRIEVED RECORDS
YES
ICASE EQ IN
NO
JJ=JJ+1
BUILD ICOORD ARRAY IN MEMORY
JJ GT 1
YES
1
WRITE ERROR MESSAGE
STOP
1

CORREL


1
CALL ARRAY
CALL MISR
WRITE: X,Y VARIANCE PRODUCT-MOMENT COR. COEFFS., NO. PAIRS
AZ = 2*A(1)-(A(3)*A(2))
BZ = 2*B(1)-(B(3)*B(2))
X = COORD(KK,1)
Y = AZ+BZ*X
DO LOOP KK = 1, JJ
ART(KK) = X
KL = JJ+KK
ART(KL) = Y
CALL PLOT
IF MORE .EQ. 0
YES
2
NO
RETURN
END

8. ARRAY

8.1 Summary

This subroutine converts data from single to double dimension or vice versa. The program is used to link the user program which contains double dimension arrays and other subroutines which operate on arrays of data in a vector fashion. This program was provided by the IBM program library.

8.2 Restrictions/Assumptions

Inputs to this subroutine occur through magnetic tape from the retrieval phase.

8.3 Options

None.

8.4 Calling Sequence: CALL ARRAY (MODE, I, J, N, M, S, D)

Where,

MODE = Code indicating type of conversion.
1 = From single to double dimension.
2 = From double to single dimension.

I = Number of rows in actual data matrix.

J = Number of columns in actual data matrix.

N = Number of rows specified for the matrix D in the dimension statement.

M = Number of columns specified for the matrix D in the dimension statement.

S = If mode = 1, this vector is input which contains the elements of a data matrix of size I by J.

Column I + 1 of data matrix follows Column I, etc.

If mode = 2, this vector is output representing a data matrix of size I by J containing its columns consecutively.

D = If mode = 1, this matrix of size N by M is output, containing a data matrix of size I by J in the first I rows and J columns.

If mode = 2, this N by M matrix is input containing a data matrix of size I by J in the first I rows and J columns.

8.5 Common Storage

None.

8.6 Subroutines Required

None.

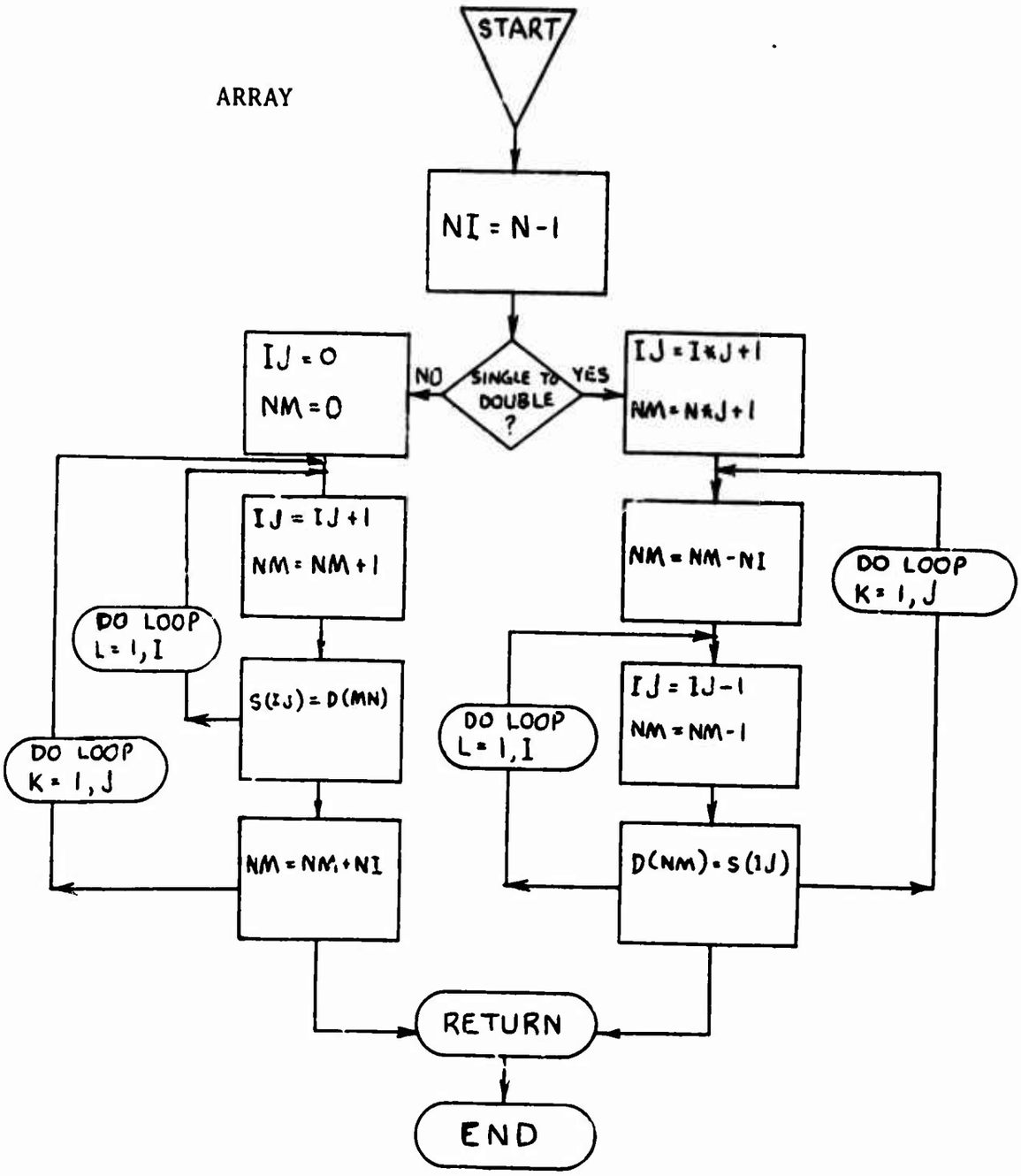
8.7 Accuracy

Single precision floating point word.

8.8 Error Messages

None.

ARRAY


START
NI = N-1
IJ = 0
NM = 0
NO
SINGLE TO DOUBLE ?
YES
IJ = I*J+1
NM = N*J+1
IJ = IJ+1
NM = NM+1
NM = NM-NI
DO LOOP K = 1, J
DO LOOP L = 1, I
S(IJ) = D(MN)
IJ = IJ-1
NM = NM-1
DO LOOP L = 1, I
DO LOOP K = 1, J
NM = NM+NI
D(NM) = S(IJ)
RETURN
END

9. MISR

9.1 Summary

This subroutine computes means, standard deviation, skewness and kurtosis, correlation coefficients, regression coefficients, and standard errors of regression coefficients when there are missing data prints. The user identifies missing data by means of a numeric code. Those values having this code are skipped in computing the statistics. In the case of the correlation coefficients, any pair of values is skipped if either one of them are missing. This program was provided by the IBM program library.

9.2 Restrictions/Assumptions

The retrieval phase must be executed before this subroutine can be used. Also, this subroutine cannot distinguish a blank and a zero. Therefore, if a blank is specified as a missing data code in input cards, it will be treated as a zero.

9.3 Options

None.

9.4 Method

Least squares regression lines and product-moment correlation coefficients are computed.

9.5 Calling Sequence

Call MISR (NO, M, X, CODE, XBAR, STD, VAR, SKEW, CURT, R, N, A, B, S, IER) where,

NO = Number of observations.

M = Number of variables.

X = Input data matrix of size NO by M.

CODE = Input vector of length M, which contains a numeric missing data code for each variable. Any observation for a given variable having a value equal to the code will be dropped.

XBAR = Output vector of length M containing means.

STD = Output vector of length M containing standard deviations.

VAR = Output vector of length M containing variance.

SKEW = Output vector of length M containing skewness.

CURT = Output vector of length M containing kurtosis.

R = Output matrix of product-moment correlation coefficients. This will be the upper triangular matrix only, since the M by M matrix of coefficients is symmetric. (Storage Mode 1)

N = Output matrix of number of pairs of observations used in computing the correlation coefficients. Only the upper triangular portion of the matrix is given. (Storage Mode 1)

A = Output matrix (M by M) containing intercepts of the regression lines (A) of the form Y=A+BX. The first subscript of this matrix

refers to the independent variable and the second to the dependent variable. Matrix A is stored in a vector form.

B = Output matrix (M by M) containing regression coefficients (B) corresponding to the values of intercepts contained in the output matrix A.

S = Output matrix (M by M) containing standard errors of regression coefficients corresponding to the coefficients contained in the output matrix B.

IER = 0, no error.

1, if number of non-missing data elements for the Jth variable is two or less. In this case, STD(J), SKEW(J), and CURT(J) are set to 10 ** 75. All values of R, A, B, and S related to this variable are also set to 10 ** 75.

2, if variance of Jth variable is less than 10 ** (-20). In this case, STD(J), SKEW(J), and CURT(J) are set to 10 ** 75. All values of R, A, B, and S related to this variable are also set to 10 ** 75.

9.6 Common Storage

None.

9.7 Subroutines Required

None.

9.8 Accuracy

Single precision floating point word.

9.9 Error Message

None.

10. PLOT

10.1 Summary

This subroutine, provided by the IBM program library, is used for plotting on a printer. It will plot a graph with one independent variable and up to nine dependent variables, with the additional ability to plot a calculated curve.

10.2 Restrictions/Assumptions

The retrieval phase must be executed before this subroutine can be used.

10.3 Options

None.

10.4 Method

The program first prints the chart number. It then calculates the extremes of X and Y, unless these are specified. A rough scale is calculated, assuming 50 divisions vertically and 100 horizontally.

The print position, YPR, is set to the maximum value of Y, and all independent variable sets, including calculated values, are searched for values of Y within one-half scale division of YPR. If any are found, an integer (1-9) is printed on that line at the proper X value. The value of the integer is that of the set of dependent variables whose Y value was matched. An asterisk is printed for a calculated value. The search is done first on calculated value, then on ascending sets of Y. Only the last match

found, if any, prints.

The print position of YPR is decremented by the scale, and the process repeated until the minimum value of Y is reached.

10.5 Calling Sequence

Call PLOT (NO, A, N, M, NFUNC, FUNC, XLAX, XLIN, YLAX, YLIN) where,

NO = A fixed point number, up to three digits, printed as the chart number.

A = A vector whose first N positions contain the independent variable, and whose next M sets of N positions contain the dependent variables.

N = The number of observations for each of the variables. If N=Ø, this means no tabulated points are to be plotted.

M = The number of variables (dependent and independent).

NFUNC = Zero or negative if no calculated curve wanted, positive if one is wanted.

FUNC = Subroutine of the form SUBROUTINE FUNC (X,Y) which returns a value of Y when given a value of X. The program calling PLOT must have an EXTERNAL FUNC statement.

XLAX, XLIN, YLAX, YLIN = Maximum and minimum values of the independent and dependent variables

to be used in the plot if XLAX=XLIN. The program calculates its own maximum and minimum for the independent variable. Program operates similarly for YLAX=YLIN.

10.6 Common Storage

None.

10.7 Subroutines Required

FUNC (if used) and SCAL.

10.8 Accuracy

Single precision floating point word.

10.9 Error Message

None.

11. SCAL

11.1 Summary

This final subroutine, an integral part of the PLOT subroutine, is used to reduce the PLOT scale by rounding the values.

11.2 Restrictions/Assumptions

This program is used in conjunction with the PLOT routine.

11.3 Options

None.

11.4 Method

The rough scale calculated by the PLOT routine is reduced to 1, 2, 2.5, or 5 times 10 to an integral power. The end points are adjusted to be multiples of the scale.

11.5 Calling Sequence

Call SCAL (X, SCAL, XMAX, XMIN).

11.6 Common Storage

None.

11.7 Subroutines Required

None.

11.8 Accuracy

Single precision floating point word.

11.9 Error Messages

None.

12. DATA REDUCTION

Part of the UNDERBRUSH Test Range support activity concerns the collecting and recording of ground truth information in conjunction with sensor flight test operations. The type and extent of the data depend primarily upon the nature of the sensor system being tested and the level of detail needed to support accurate evaluation. The ground truth information obtained can be divided into three segments: mission data, target information, and atmospheric observations. Mission data pertain essentially to aircraft flight information such as heading, altitude, time over target, and the start and end times for each sortie. Target information typically includes the type, location, orientation, and dimensions of each target and, when required, such specialized information as surface reflectivity and thermal measurements. Data on cloud condition, temperature, precipitation, wind, and solar radiation are included within the atmospheric observation category.

The objective of the Computer Assisted Target Analysis program was to design and test a computer program to store, retrieve, and correlate selected ground truth information. Before the computer program could be created, however, selection of ground data parameters had to be accomplished. Unfortunately the types of ground information being collected and the manner in which they are presented has not remained constant. Hence, one of the first tasks in the program was to search through the UNDERBRUSH ground truth files and list all the information categories. From this list 32

data parameters were selected for inclusion. A short description of these parameters follows.

1. Mission Name and Number - This nomenclature is included only if the imagery is on file at the RADC/EMIRC Reconnaissance Data Base.
2. Sensor Type - Type of sensor, e.g., Radar, IR, Photo, Laser.
3. Sensor Designation - Sensor system identification name.
4. Date - Date of ground truth observation.
5. Aircraft - Type of aircraft carrying sensor equipment.
6. Location - Site where atmospheric observations were collected. (See Appendix A)
7. Sunrise - Local time of sunrise.
8. Sunset - Local time of sunset.
9. Moonrise - Local time of moonrise.
10. Moonset - Local time of moonset.
11. Time - Local time of each recorded observation.
12. Sky Cover - Amount of cloud cover. (See Appendix A)
13. Cloud Height - Estimated height of clouds above the ground in thousands of feet.
14. Cloud Type - Type of cloud formation. (See Appendix A)
15. Wind Direction - Wind direction relative to the eight points of the compass.

16. Wind Speed - Velocity in knots.

17. Weather Status - Weather phenomena at time of observation. (See Appendix A)

18. Wet Bulb - Wet bulb temperature reading in tenths of degrees F.

19. Dry Bulb - Dry bulb temperature reading in tenths of degrees F.

20. Relative Humidity - Percent of relative humidity.

21. Solar Radiation - Reading of solar radiation recorded in hundredths.

22. Precipitation - Amount of precipitation occurring between the time of observations.

23. Ground Visibility - Estimate of visibility.

24. Dew Point - Dew point temperature in tenths of degrees F.

25. Reference Cube - Reference temperature value in tenths of degrees C applied to radiometric readings.

26. Background Results - Background reading of radiometer in tenths of degrees C.

27. Background Temperature - Background temperature in tenths of degrees C.

28. Moon Phase - Moon phase to nearest quarter.

29. Standard Brightness - Reference value applied to footlamberts reading.

30. Background Brightness - Background brightness in footlamberts.

31. Sun/Moon Shadow - Direction of shadow angle in degrees.

32. Foliage - Amount of foliage coverage at place of recorded observation. (See Appendix A)

In order to minimize the amount of computer storage, yet include complete data, alphabetic and numeric codes were developed. Appendix A lists these codes along with their representative values. The encoded ground information was transcribed onto a format sheet and then to a keypunch data card. Since two cards were needed to record a set of data for a given observation time, a sequential number was assigned to each punch card to ensure correct order. The punch card format is as follows:

CARD 1

COLUMNS	ITEM	FORMAT
1 - 5	MISNAM - Mission Name	A5
6 - 9	MISNUM - Mission Number	A4
11	SENTYP - Sensor Type	I1
13 - 14	SENDES - Sensor Designation	I2
16 - 21	IDATE - Date	I6
23 - 25	AIRCRF - Aircraft	A3
27	LOCAT - Location	A1
29 - 32	SUNRIZ - Sunrise	I4
34 - 37	SUNSET - Sunset	I4

39 - 42	MUNRIZ - Moonrise		I4
44 - 47	MUNSET - Moonset		I4
49 - 52	LOCTIM - Time (Local)		I4
54	SKYCOV - Skycover		I1
56 - 57	CLHITE - Height (Clouds)		I2
59	CLTYPE - Type (Clouds)		I1
61 - 62	WINDIR - Wind Direction		A2
64 - 65	WINSPD - Wind Speed (Knots)		A2
67 - 68	WESTAT - Weather Status		A2
70 - 72	WETBUB - Wet Bulb (F)		I3
** 77 - 80	Sequential Card Identification- Never Read, Written, or Processed		I4

CARD 2

COLUMNS	ITEM	FORMAT
1 - 3	DRYBUB - Dry Bulb (F)	I3
5 - 7	RELHUM - Relative Humidity %	I3
9 - 11	SOLRAD - Solar Radiation	I3
13	PRECIP - Precipitation	A1
15	GRDVIS - Ground Visibility	I1
17 - 18	DEWPTF - Dew Point (F)	I2
20 - 22	REFCUB - Reference Cube	I3
24 - 26	BGRRES - Background Results	I3
28 - 30	BGRTEM - Background Temp (C)	I3
32	MUNPHA - Moon Phase	I1
34 - 37	SBRITW - Standard Brightness (Whole)	I4

38 - 42	SBRITD -	Standard Brightness (Decimal)	I5
44 - 47	BBRITW -	Background Brightness (Whole)	I4
48 - 52	BBRITD -	Background Brightness (Decimal)	I5
54 - 56	SUMOSH -	Sun/Moon Shadow	I3
58	FOLIAG -	Foliage	I1
** 77 - 80		Sequential Card Identification- Never Read, Written, or Processed	I4

A total of 3,108 observations were encoded and 6,216 data cards were keypunched, machine verified, sorted into proper sequence, and stored on magnetic tape. In addition, ground truth information covering Fort Sill and Fort Knox were also processed, although those data could not be incorporated as part of the UNDER BRUSH test records.

13. COMPUTER TEST RESULTS

This section presents the results of the various tests undertaken in conjunction with the RADC Program Monitor to check out the operation of the computer program and to demonstrate the utility of the program in support of UNDERBRUSH evaluations. All the computer operations were conducted using the GE-645 computer at Rome Air Development Center. For complete instructions concerning the set-up of the card deck and the operational procedures refer to Section 2 of this report.

Although the following examples cover different situations, the basic computer procedure remains the same. First the requestor specifies the categories and limits of information to be retrieved. The computer then searches the master magnetic tape containing all the UNDERBRUSH records and retrieves those sets of data which comply with the requested parameters. Retrieval is accomplished by copying the desired sets of observations onto a spare magnetic tape. This spare tape is then used to generate a listing of requested information as well as the input to the correlation program.

It should be noted that because of the nature of the data being collected for any given set of UNDERBRUSH observations some of the categories contain no information; hence, a blank is recorded on the master tape. However, the GE-645 computer treats a blank as a zero. Therefore, during the correlation phase if either of the parameters being analyzed contains blanks the

resultant computation is distorted. To prevent this possibility, the retrieval case should include the correlation parameters. This ensures that the input to the correlation phase contains complete data.

13.1 Dry Bulb and Wet Bulb Temperature Vs. Solar Radiation

The purpose of this test was to determine whether solar radiation is related to temperature, and if so, whether the dry bulb temperature or wet bulb temperature is more important. The first step was to retrieve all the UNDERBRUSH observations containing solar radiation readings, then compare the temperature readings with values for solar radiation. A total of 920 observations, 552 dry bulb and 368 wet bulb, were retrieved which when correlated produced the following results:

Average dry bulb temperature	70.1°F
Average wet bulb temperature	59.8°F
Average solar radiation from dry bulb observations	0.59
Average solar radiation from wet bulb observations	0.63
Correlation coefficient with dry bulb	0.28
Correlation coefficient with wet bulb	0.03

Analysis shows that there is a slight tendency for solar radiation to be related to dry bulb temperature at least in comparison with the wet bulb readings. However, it is also evident from the low

correlation coefficient values that ambient air temperature does not vary proportionately with the intensity of solar radiation.

13.2 Dry Bulb Temperature Vs. Solar Radiation for Various Sky Conditions

In the previous example solar radiation and temperature were correlated with mixed results. Here the problem has been further refined by comparing data obtained under similar sky conditions. Four types of sky cover were differentiated: clear, scattered, broken, and overcast conditions.

Results of the computer calculations show a distinct relationship between the amount of cloud cover and solar radiation intensity. As would be expected radiation level decreases as the cloud cover increases. By the same token the product-moment correlation coefficient increases steadily indicating that under cloudy conditions a relationship seems to exist between radiation intensity and dry bulb temperature. This relationship, however, is not strong enough to be causal, but rather may be associated with other atmospheric factors.

SKY CONDITION	DRY BULB °F	SOLAR RADIATION	CORRELATION COEFFICIENT
Clear	68.1	0.69	0.16
Scattered	72.4	0.68	0.28
Broken	76.7	0.53	0.42
Overcast	64.6	0.27	0.41

13.3 Background Temperature Vs. Background Radiometer Results

The intensity of infrared radiation from a given object is a function of its surface temperature and emissivity. Since the background radiation readings collected at the UNDERBRUSH Test Range were obtained by sampling the ground, it can be assumed that the emissivity effect would be relatively constant and hence would not be much of a factor in determining changes in radiation levels. If the above assumptions are correct a close correlation should exist between background temperature and background radiation. To check the validity, all the UNDERBRUSH temperature and radiation data were retrieved on tape and then processed through the correlation routine to obtain the correlation coefficient. The computer results showed that the product-moment correlation coefficient was 0.91 indicating a very high correlation between the background temperature readings and background radiation levels.

13.4 Windspeed Vs. Background Radiometric Readings

The objective of this test was to investigate whether the velocity of wind affects the intensity of terrestrial radiation. The first step was to determine what type of data should be retrieved and define the parametric limits. Since terrestrial radiation is primarily a function of surface temperature, which in turn is strongly influenced by sunlight, only those observations recorded at night between 2030 and 2400 hours were considered. In addition, the data being retrieved were separated into groups based upon dry bulb temperature readings.

Statistical results of the 173 observations retrieved are as follows:

Mid-Point Dry Bulb Temperature	32.5°F	47.5°F	62.5°F	77.5°F
Average Radiometric Reading	4.9°C	10.2°C	19.6°C	26.9°C
Correlation Coefficient	0.37	-0.04	0.21	-0.17

Judging from the rather erratic product-moment correlation coefficient values it would appear that the effect of wind on the intensity of terrestrial radiation is minor compared to other factors. Indeed the increase of radiometric readings with respect to increased air temperature is vividly demonstrated by the results. However, two-thirds of the radiometric readings were collected under calm wind conditions and in only 13 instances was the wind speed greater than 5 knots. More data are needed, especially under higher wind velocities before conclusive results can be obtained.

13.5 Variable Relative Humidity Vs. Solar Radiation

The purpose of this final example was to determine if the UNDERBRUSH data showed any correlation between the intensity of solar radiation and relative humidity. Since the intensity of solar radiation varies throughout the daytime, generally being highest around mid-day and lowest at dawn and dusk, only those solar radiation readings obtained between 1000 and 1500 hours local time were considered. The search parameters were further refined by requesting that the retrieved data be separated into two groups, one having relative humidity values between 40 and 60

percent, and the other between 90 and 100 percent. After the search function was completed 83 records were retrieved, 78 containing low relative humidity values and only [illegible] with high humidity.

Results of the correlation showed that for the first group the average relative humidity was 49 percent and the solar radiation value 0.81. The second group had an average relative humidity reading of 98 percent and a corresponding solar radiation value of only 0.51. Thus, a solar radiation difference of 0.30 exists between the two groups. The product-moment correlation coefficient value for the first group was computed to be -0.19 indicating a slight inverse correlation. Yet the second group showed a very strong inverse correlation of -0.70. From the data it appears that although low humidity does not influence the intensity of solar radiation very much, high humidity is indeed an important factor. As the humidity level approaches the saturation point the amount of incoming solar radiation decreases. This indicates that atmospheric absorption of short wave solar radiation is more pronounced as the percent of water vapor in the atmosphere reaches a maximum.

Unfortunately the limited amount of data available concerning high humidity values prohibits conclusive analysis, especially since an apparently abnormal radiation reading was included. For instance, portions of the five observations are as follows:

DATE	TIME	RELATIVE HUMIDITY(%)	SOLAR RADIATION
660927	1330	100	0.20
660927	1400	100	0.25
660927	1430	100	0.32
670708	1330	96	0.39
670708	1400	96	1.40

As can be seen, four of the five solar radiation values are reasonably close together, yet the fifth one is way out of line, especially considering that the last two observations were sequentially recorded one-half hour apart on the same day. If the last observation were deleted, the inverse correlation between solar radiation and relative humidity would become even stronger.

14. CONCLUSIONS AND RECOMMENDATIONS

The objective of the Computer Assisted Target Analysis program, that is, to design and test a computer program to store, retrieve, and correlate selected ground truth information, was accomplished. The UNDERBRUSH data gathered from the advent of the test range until April 1969 were encoded, keypunched, and stored on magnetic tape. In addition, atmospheric observations covering Fort Sill and Fort Knox also were processed.

In the preceeding section specific examples testing the search, retrieval, and correlation techniques of the computer program were described. The program utility is by no means limited to those types of data manipulation. Some other considerations are described below.

1. Since the master tape contains data covering three years of UNDERBRUSH observations, some climatic information can be obtained from the program. For instance, one of the problems encountered in planning a sensor test exercise is to estimate the number of flying days. Although the UNDERBRUSH data were collected only during active operations, the amount of cloud cover and ceiling height for a given period can be determined, thus providing an indication of the typical sky condition which can be anticipated.

2. Although there are other program functions, such as storing additional data on the master tape, the search and retrieval function is undoubtedly the most important. Through the use of search input cards the program user can define the data to be searched and retrieved. The actual retrieval can be output in several ways: printed out by the computer, transferred to another magnetic tape, or punched on data cards. These output options provide a versatility which can be useful for other projects. An example might be a study on low light level TV operating requirements which could incorporate the UNDERBRUSH Test Range nocturnal illumination readings. The illumination data could be punched out on cards by the computer, then compiled with data from other sources.

3. The basic computer program can be exploited for other uses besides UNDERBRUSH data analysis. By modifying the data categories a search and retrieval system could be utilized for such projects as the data base imagery file, multisensor target inventory, and SEA support data analysis. Any information that lends itself to encoding can be readily handled.

Data reduction for the Computer Assisted Target Analysis program consisted primarily of atmospheric observations; however, consideration should be given toward expanding the project to include specific flight and target information. Data have already been collected at the UNDERBRUSH Test Range covering such diverse items as aircraft heading and altitude, sensor mode stations, radiometric and thermal readings of specific targets, MTI information, and location and orientation of static arrays. The usefulness of such data for sensor evaluations would be enhanced if they were more readily accessible.

APPENDIX A

A. COMPUTER ASSISTED TARGET ANALYSIS ENCODING KEY

A.1 Sensor Type - SENTYP

1 - Radar

2 - Infrared

3 - Photography

4 - Laser

A.2 Sensor Designation - SENDES

Refer to RADC/EMIRC Reconnaissance Data Base sensor codes.

A.3 Location - LOCAT

A - Site 1

B - Site 2

C - Site 3

D - Site 4

E - SAM Site

F - Sampan

G - General UNDERBRUSH Area

H - Triangle

I - Intercoastal Waterway

J - Route 283

K - POL

L - Range 70

M - Holley Field

N - Range C-52

O - Rock Hill Assault Strip

P - Clay Pit

Q - Range C-74

R - Fort Knox

S - Range B-75

T - Fort Sill

A.4 Sky Cover - SKYCOV

1 - Clear

2 - Scattered Clouds

3 - Broken Clouds

4 - Overcast

5 - Obscured

A.5 Cloud Type - CLTYPE

1 - Cirrus
2 - Cirrostratus
3 - Stratus
4 - Altostratus
5 - Altocumulus
6 - Cumulus
7 - Stratocumulus
8 - Cumulonimbus

A.6 Weather Status - WESTAT

A - Hail
BN- Blowing Sand
D - Dust
F - Fog
GF- Ground Fog
H - Haze
K - Smoke
L - Drizzle
RW- Rain Showers
S - Snow
T - Thunderstorm
ZL- Freezing Drizzle

A.7 Precipitation - PRECIP

Numerical - Amount of precipitation in tenths of an inch.

OR

H - Heavy
L - Light
M - Moderate
S - Slight
T - Trace

A.8 Ground Visibility - GRDVIS

1 - Excellent
2 - Good
3 - Fair
4 - Poor

A.9 Moon Phase - MUNPHA

1 - One-quarter full

2 - One-half full

3 - Three-quarter full

4 - Full

5 - No moon

A.10 Foliage - FOLIAG

1 - Open

2 - Light

3 - Medium

4 - Dense

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13. ABSTRACT

The Computer Assisted Target Analysis program cataloged in computer form the ground truth data collected at the UNDERBRUSH Test Range, Eglin Air Force Base, Florida. A Fortran IV program compatible with the GE-645 computer was developed for storing, retrieving, and correlating the data, and providing a means for updating as more data are compiled. Contained within is a complete program documentation including step by step operating procedures and logic flow diagrams. In addition, the data reduction methodology and program test results are described.

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